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ABSTRACT

This module, 1 of 10 in the Drafting curriculum guide developed in Missouri, contains 3 units of study that include some or all of the following components: performance objectives, lesson plans, information sheets, transparency masters, handouts, assignment sheets, job sheets, a unit test, and answers to the unit test. Special instructions on using audiovisual aids, supplies, and equipment are included in notes to the instructor section near the beginning of each unit. All units are competency based and cross-referenced to a competency profile at the beginning of the module. The units cover the following topics: (1) introduction to electronic drawings; (2) introduction to machine drawings; and (3) introduction to sheet metal drawings. (KC)

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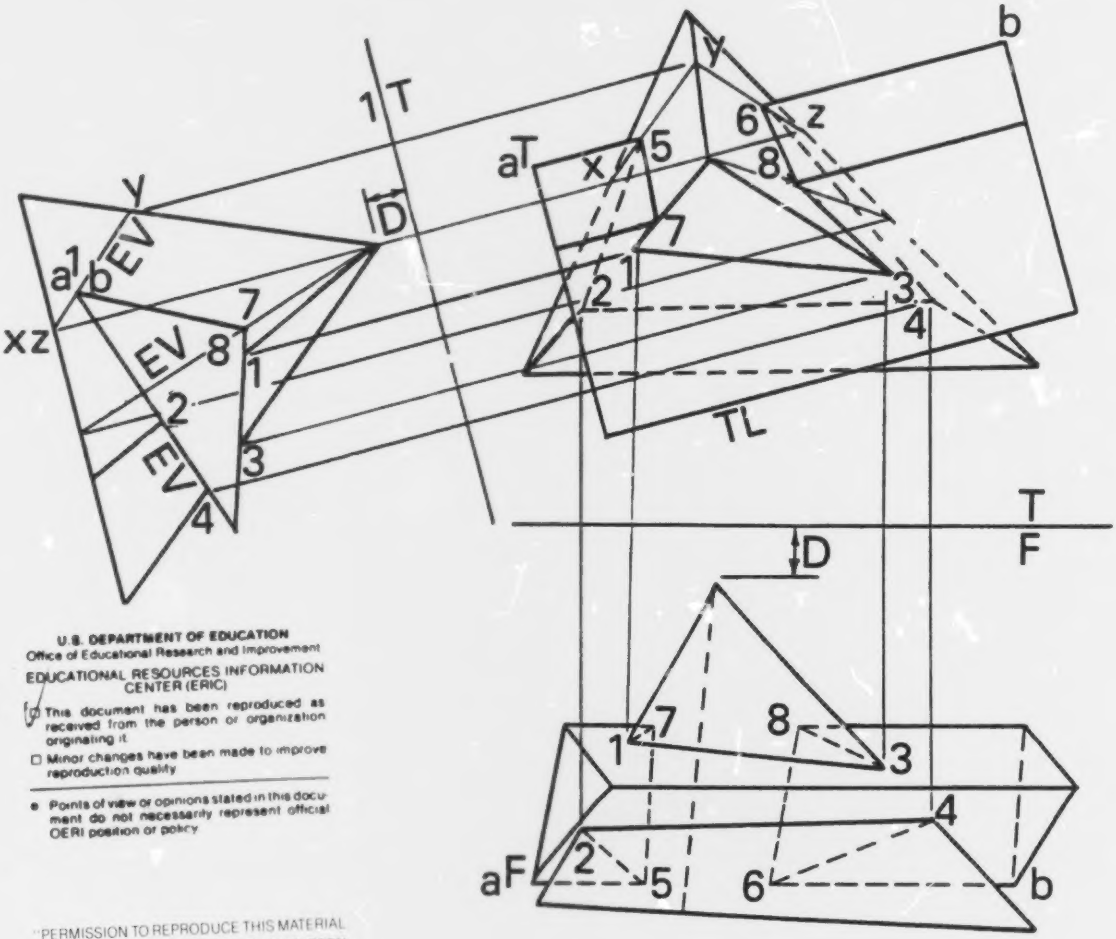
Module

8

INTRODUCTION TO PRODUCTION/MANUFACTURING DRAFTING

70-4008-I
Instructor's Guide

ED355451



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DRAFTING

Module 8: Introduction to Production/Manufacturing Drafting

Instructional Materials Laboratory
8 London Hall
University of Missouri-Columbia
Columbia, MO 65211

1992

Instructor's Guide
Catalog N. 70-4008-I

FOREWORD

Once again, we are indebted to the teachers and administrators who provided their time, effort, and professionalism to develop curriculum guides for trade, technical, and industrial education programs. This drafting guide is an outstanding example of what can be accomplished when the right people with the right attitude get together. Committee members worked hard over several years' time in advisory, writing, technical consultation, and field-test capacities.

This guide is designed to be totally integrated with the Vocational Instructional Management System. It is hoped that all guides produced under our supervision will help classroom teachers manage instruction. A curriculum guide is more than a resource--it is an integral part of the management system. Rather than impeding instruction, it should guide and facilitate instruction.

This guide's format has been set up for competency-based teaching and testing. Unit tests evaluate specific competencies and can be used with the Vocational Administrative Management System (VAMS). Information sheets, transparency masters, assignments sheets, and test items are keyed to specific competencies. A cross-reference table has been included to quickly identify the parts of the curriculum that relate to specific competencies.

Although this guide may be a new format for some teachers, we are confident that, when used as designed, time spent by teachers and students will become more productive. Any future drafting curriculum modifications will begin with this guide. The drafting field is undergoing constant and considerable change. We will evaluate the need to update this guide on a module-by-module basis. Your suggestions regarding areas for improvement are both encouraged and appreciated.

Carrie Haner, supervisor
Industrial Education
Department of Elementary and Secondary Education

Charles "Chuck" Waibel, director
Industrial Education
Department of Elementary and Secondary Education

ACKNOWLEDGEMENTS

This drafting guide represents a continuing commitment to Missouri's Vocational Instructional Management System (VIMS). The guide has been keyed to the drafting competency profile developed by industry and education professionals in the state.

When searching for current drafting materials to adopt or use in the guide's development, comparable materials were found from the Mid-America Vocational Curriculum Consortium (MAVCC), of which Missouri is a member. MAVCC materials, therefore, have been relied upon as a resource for this guide. A debt of thanks is owed to the entire MAVCC organization for the research and development of these drafting materials.

Special appreciation is given to the writers for their self-motivation, reliability, and technical expertise.

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Support and contributions of IML staff members were instrumental to this module's development.

Harley Schlichting, director
Amon Herd, associate director
Phyllis Miller and Dan Stapleton, assistant directors
Veronica Feilner, editor

Technical assistance was provided by the Academic Support Center, University of Missouri-Columbia.

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Unit I: Introduction to Electronic Drawings 1

Unit II: Introduction to Machine Drawings 41

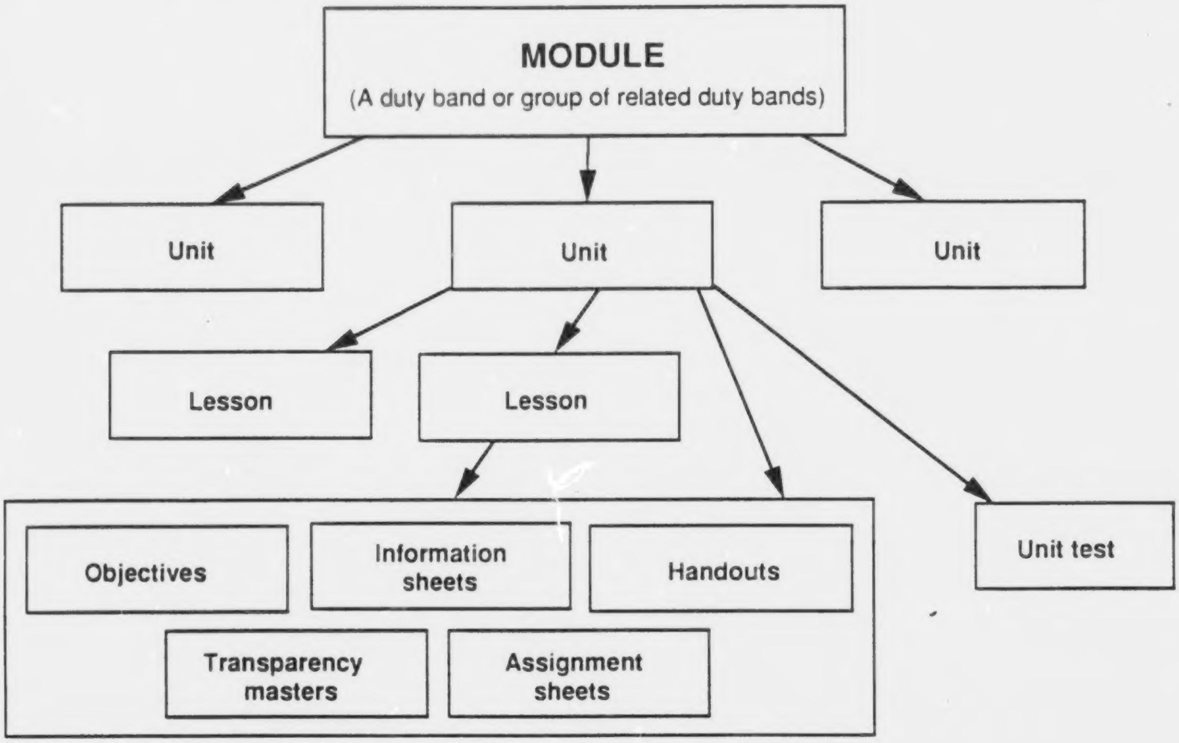
Unit III: Introduction to Sheet Metal Drawings 205

HOW TO USE THIS PUBLICATION

GUIDE COMPONENTS

Units of instruction

This Drafting guide contains ten modules of instruction. Within each module are instructional units including some or all of the following components: performance objectives, information sheets, transparency masters, handouts, assignment sheets, job sheets and a unit test. Special instructions on audiovisuals, supplies, etc., are included in the "Notes to the Instructor" section near the beginning of each unit.



Competency profile

On the Missouri competency profile, tasks are divided into general subject areas, or duty bands, which are identified by a capital letter. Under each duty band are related tasks (competencies), which are identified by an Arabic numeral. To evaluate the student on performance of the competencies, a 3-2-1-N grading system is used, where:

3 = **Mastery** - can work independently with no supervision
2 = **Requires supervision** - can perform job completely with limited supervision
1 = **Not mastered** - requires instruction and close supervision
N = **No exposure** - no experience or knowledge in this area

Cross-reference table (color-coded white)

Once the numbering system is understood, this table quickly reveals how the instructional components of the module relate to Missouri competencies. On the competency profile, tasks are divided into general subject areas, or duty bands, which are identified by a capital letter. Under each duty band are related tasks (competencies), which are identified by an Arabic numeral.

On the cross-reference table, unit numbers are represented by Roman numerals (I, II, III, etc.). Lessons within a unit are shown with Arabic numerals. Objectives and other components of the module (transparencies, handouts, and assignment sheets) are number consecutively throughout each unit. By looking at the cross-reference table, the instructor can quickly determine what test questions or assignment sheets a student needs to be evaluated on for a particular competency.

Objectives (color-coded white)

Each unit is based on performance objectives that state the measurable unit and specific behavioral or performance objectives that students are expected to achieve. Since the objectives of the unit provide direction for the teaching-learning process, it is important for the teacher and students to have a common understanding of the objectives. Teachers should feel free to add/adapt objectives which will fit the material to student and community needs. Supporting material will, of course, need to be added for any new objectives.

Table of contents, references, notes to the instructor (color-coded pink)

These pages have been coded pink for instructor use only. The "Table of Contents" lists lesson titles and the transparency masters, handouts, and assignment sheets in each lesson. The "Reference Section" lists materials used as sources in developing the material. Special instructions on audiovisuals, supplies, etc., are included in the "Notes to the Instructor" section.

Information sheets (color-coded green)

Presented in outline form for clarity, these pages provide content essential for meeting the cognitive (knowledge) objectives in the unit. Students should study the information sheets before class discussion or completion of assignment sheets. **CAUTION** statements indicate possible equipment damage, while **WARNING** statements recommend procedures to avoid bodily injury. Handouts and transparency masters are noted in the information sheets for instructional use.

Transparency masters (color-coded white)

Transparencies provide information by visually reinforcing or clarifying ideas presented in the information sheets. They are effective when identification is necessary, and they direct students to the topic of discussion. Transparencies should be left on the screen only when topics shown are under discussion.

Handouts (color-coded white)

Whenever more detailed information than can be presented in a transparency is needed, a handout is used. Handouts give the students additional information that can be kept with their class notes or student references.

Assignment sheets (color-coded tan)

Assignment sheets provide students with paper-and-pencil activities that give students the opportunity to make practical application of the knowledge presented in the information sheets. The answers to the assignment sheets (color-coded pink) have been provided to assist the instructor in evaluating student performances. Many of the assignment sheets must be evaluated to the satisfaction of the instructor.

Unit test (color-coded yellow)

Competency-based tests are designed to help eliminate subjective testing and to improve student evaluation and accountability. Specific competencies and test questions are linked on the answer key. These unit tests have been written to be used with computerized VAMS (Vocational Administrative Management System), using Scantron sheets for computer-recording of test answers. If additional objectives have been added, additional test items will also need to be added.

It is recommended that the test be divided into shorter tests covering three or four objectives at a time and given soon after those objectives have been covered. A selection of test items from the units covered may be used for final tests at the end of each term if desired.

SUGGESTED ACTIVITIES

The following list of suggested activities may be helpful, especially to the beginning instructor.

1. Provide students with objective sheet and information sheets.
2. Discuss unit and specific objectives.
3. Discuss information sheets and assignment sheets lesson by lesson.
5. Give students unit test and assignment sheets.

Students should perform the following activities.

1. Read objective sheet.
2. Study information sheets.
3. Take unit test and do assignment sheet(s).

Drafting

Module: Introduction to Production/Manufacturing Drafting

Cross-Reference Table of Instructional Materials

Competency	Unit	Instructional Objective	Transparency Master	Handout	Assignment Sheet	Test Item	Notes
L-1	I	1.1-1.6	1.1-1.8	1.1		1-14	
L-2	I	1.1-1.6	1.1-1.8		1.1	1-14	
O-1	II	2.1-2.40	2.1-2.28		2.1-2.14	1-208	
O-2	II	2.1-2.7	2.1-2.4		2.4, 2.5	1, 2, 4, 5, 8, 11, 14-25, 28	
O-3	II	2.19-2.39	2.11-2.28		2.11-2.14	96-99, 116-208	
Q-2	III	3.1-3.5	3.1-3.12		3.1-3.6	1-22	
Q-3	III	3.1-3.5	3.1-3.12		3.1-3.6	1-22	

MODULE: INTRODUCTION TO PRODUCTION/MANUFACTURING DRAFTING

UNIT I: INTRODUCTION TO ELECTRONIC DRAWINGS

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify component symbols. The student should also be able to draw a schematic diagram and select components from reference materials. This knowledge will be evidenced by correctly performing the procedures outlined in the assignment sheet and by scoring _____ percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1.1 Match terms related to component identification with the correct definitions.

1.2 Identify component symbols.

1.3 Complete a chart of abbreviations.

1.4 Complete a chart of reference designation class letters.

1.5 Identify information about a component using reference designations.

1.6 Demonstrate the ability to draw a schematic diagram (AS 1.1).

MODULE: INTRODUCTION TO PRODUCTION/MANUFACTURING DRAFTING

UNIT I: INTRODUCTION TO ELECTRONIC DRAWINGS

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the instructor

D. Lesson plan

   1. **Lesson 1: Component Identification** 5

      a. Information outline

      b. Transparency masters

         TM 1.1: Resistors
         TM 1.2: Capacitors
         TM 1.3: Inductors and Transformers
         TM 1.4: Diodes
         TM 1.5: Transistors
         TM 1.6: Integrated Circuits
         TM 1.7: Switches
         TM 1.8: Reference Designations

      c. Handout

         HO 1.1: Reference Designation Class Letters

      d. Assignment sheet

         AS 1.1: Draw a Schematic Diagram

      e. Answers to assignment sheet

E. Unit test

F. Answers to unit test

REFERENCES

A. Allied Electronic 1981 Engineering Manual and Purchasing Guide, No.810. Fort Worth, TX: Allied Electronics/Spartan Manufacturing Corp., 1981.

B. ANSI Standards - Y32.16 - 1975. New York: Institute of Electrical and Electronic Engineers.

C. Archer Semiconductor Reference Handbook, No. 276-4001. Fort Worth, TX: Radio Shack/Tandy Corp., 1977.

D. Lindsey, Darryl. The Design and Drafting of Printed Circuits. Revised ed. Westlake Village, CA: Bishop Graphics, Inc., 1982.

E. McClain, Gerald R. and Neal A. Willison. Electron Drafting. Stillwater, OK: Mid-America Vocational Curriculum Consortium, Inc., 1983.

F. Newark Electronics Catalog, No. 105. Chicago, IL: Newark Electronics/Premier Industrial Corp., 1981.

G. Rowbotham, George E., editor. Engineering and Industrial Graphics Handbook. New York, NY: McGraw-Hill Book Co., 1982.

H. Villanucci, Robert S., et. al. Electronic Techniques: Shop Practices and Construction. 2nd ed. Englewood Cliffs, NJ: Prentice-Hall Inc., 1981.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. Review HO 1.1.

   NOTE: You may wish to give a quiz over this additional material.

2. Have students physically examine electronic components, looking for indexing tabs, polarity markings, or color coding.
3. Set up a display of electronic components and have students identify the components.
4. Have students visit an electronic parts store and report on the various components available.
5. Have students write to component manufacturers to obtain copies of their catalogs.

MODULE: INTRODUCTION TO PRODUCTION/MANUFACTURING DRAFTING

UNIT I: INTRODUCTION TO ELECTRONIC DRAWINGS

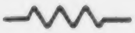
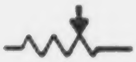
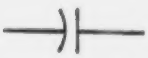
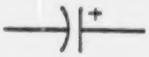
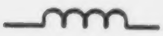
LESSON 1: COMPONENT IDENTIFICATION

I. Terms and definitions

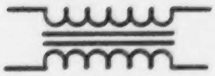
- A. **Anode**--positive end of a diode
- B. **Cathode**--negative end of a diode
- C. **Color code**--a standard coding system, using colors, to indicate the electronic values of resistors and capacitors
- D. **Component**--a single electronic device
- E. **Extractor**--tool used to help remove an integrated circuit
- F. **Heat sink**--metal configuration used to absorb and dissipate heat
- G. **Indexing**--a method of coding used to locate the leads or pins of an electronic component
- H. **Potentiometer**--a type of variable resistor
- I. **Reference designation**--a letter or group of letters and numbers that identify both the symbols and the components they represent on the schematic

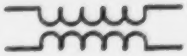
  NOTE: This is also referred to as a class designation.
- J. **Symbol**--a graphical representation of a component

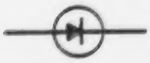
II. Component symbols (TMs 1.1-1.7)

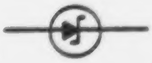
- A. Resistors
  - 1. Fixed 
  - 2. Variable (potentiometer) 
- B. Capacitors
  - 1. Fixed 
  - 2. Polarized 
- C. Inductors 

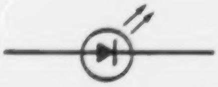
D. Transformers

1. With magnetic core 

2. Without magnetic core 

E. Diode 

F. Zener diode 

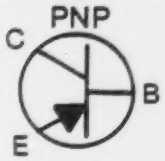
G. Light emitting diode (LED) 

H. Transistors

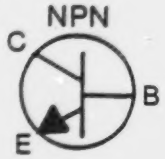
1. Bipolar transistors

NOTE: The following abbreviations are used: C - collector, E - emitter, and B - base.

a. PNP



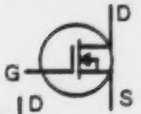
b. NPN



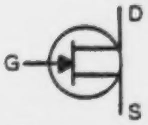
2. Field effect transistors (FETs)

NOTE: The following abbreviations are used: G - gate, D - drain, and S - source.

a. MOSFET

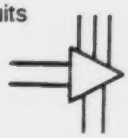


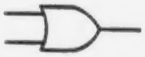
b. JFET



NOTE: There are many variations of these symbols used to represent other transistors.

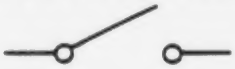
I. Integrated circuits

1. Analog 

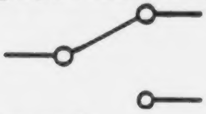
2. Digital 

J. Switches

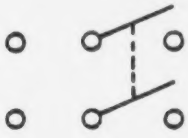
1. Single pole single throw



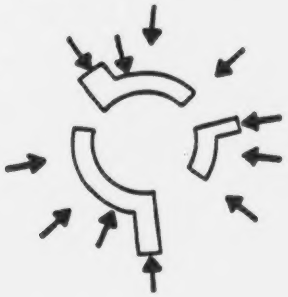
2. Single pole double throw



3. Double pole double throw

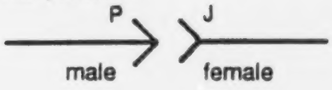


4. Rotary wafer

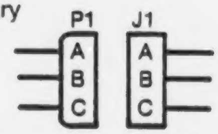


K. Connectors

1. Male/female



2. Removable/stationary



Removable connector Stationary connector

III. Abbreviations

NOTE: Abbreviations are commonly used in general and specific notes on drawings.

A. Resistor--RES

B. Potentiometer--POT

C. Printed circuit--PC

D. Printed circuit board--PCB

E. Dual in-line package--DIP

F. Capacitor--CAP

G. Transformer--XFMR

H. Transistor--XSTR

I. Rectifier--RECT

J. Integrated circuit--IC

K. Single pole single throw switch--SPST

L. Single pole double throw switch--SPDT

M. Double pole double throw switch--DPDT

N. Connector--CONN

IV. Reference designation class letters (HO 1.1)(ANSI Y32.16 - 1975)

NOTE: Reference designation class letters should not be confused with abbreviations. Reference designations are used with the symbol in the drawing for parts identification.

A. Resistor--R

B. Capacitor--C

C. Inductor--L

D. Transformer--T

E. Diode--CR

F. Zener diode--VR

G. Light emitting diode--DS

H. Transistor--Q

I. Integrated circuit--U

J. Switch--S

K. Plug--P

L. Jack--J

NOTE: Other reference designations are included in Handout #1, but those are additional and will not appear on this test.

V. Using reference designations (TM 1.8)

A. Class letter

NOTE: These are listed in the previous objective and in HO 1.1.

B. Number--how many; determined from schematic

C. Suffix letter--used if component is a portion of a multi-element part

D. Terminal--number or letter

Example: K1A-5

K = Device is in relay family

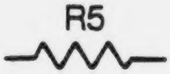
1 = First relay designated on schematic

A = Side A of a multi-element relay

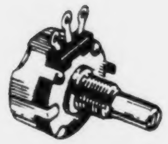
5 = Contact terminal number 5 of the relay

RESISTORS

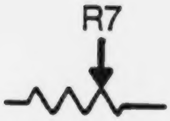
Carbon Composition
with Color-Coded Markings



Symbol

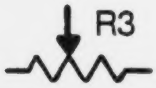


Potentiometer

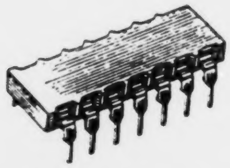


Symbol

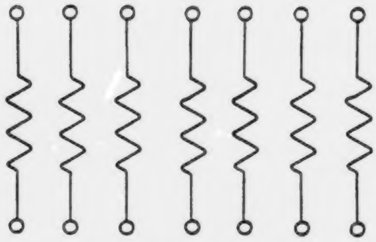
PC Mounted
Potentiometer



Symbol



Dual In-Line Package
Resistor Network

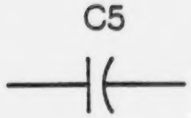


Symbol

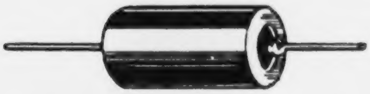
Reference Designation for all Resistors: R
Unit Designation for all Resistors: Ohms or Ω

CAPACITORS

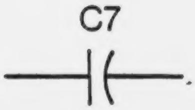
Disc Capacitor



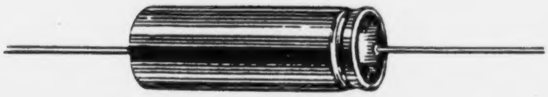
Symbol



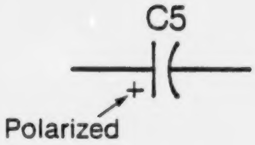
Tubular Capacitor



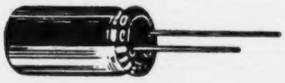
Symbol



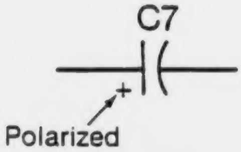
Axial Lead Electrolytic
Capacitor -Polarized



Symbol



Radial Lead Electrolytic
Capacitor -Polarized

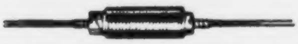


Symbol

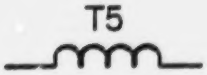
Reference Designation for all Capacitors: C
Unit Designation for all Capacitors: Farad

INDUCTORS AND TRANSFORMERS

Inductors:



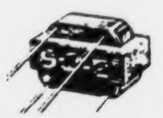
Axial Lead RF Choke



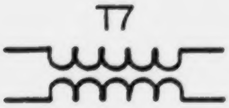
Symbol

Reference Designation for all Inductors: L
Unit Designation for all Inductors: Henry

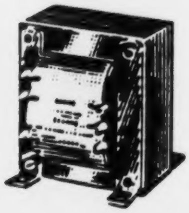
Transformers:



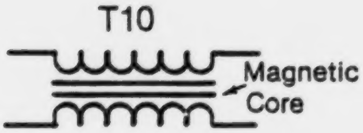
Miniature Transformer



Symbol



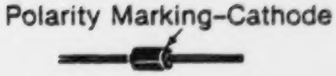
Power Transformer



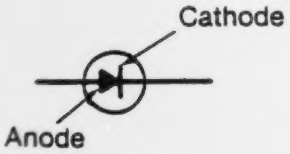
Symbol

Reference Designation for all Transformers: T
Unit Designation for all Transformers: Volts

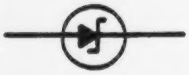
DIODES



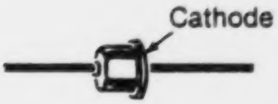
Axial Diode
With Polarity Markings



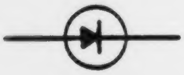
Diode
Symbol



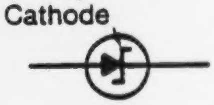
Zener Diode
Symbol



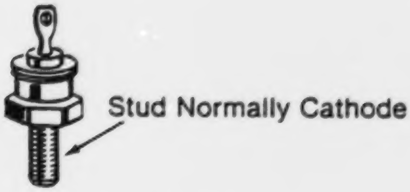
Top Hat Diode



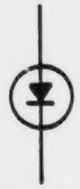
Diode
Symbol



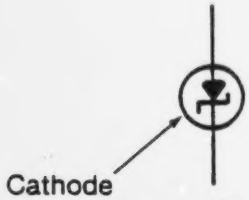
Zener Diode
Symbol



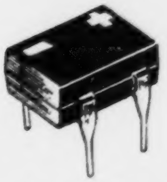
Stud Mounted Diode



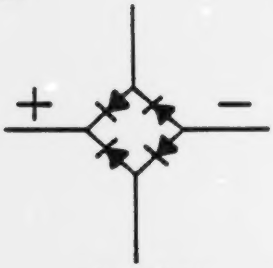
Diode
Symbol



Zener Diode
Symbol

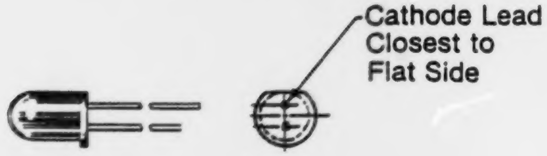


PC Bridge Rectifier

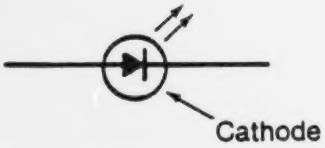


Symbol

Reference Designation for Diodes: CR
Reference Designation for Zener Diode: VR



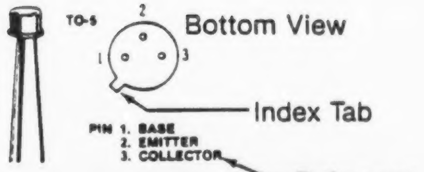
Light Emitting Diode (LED)



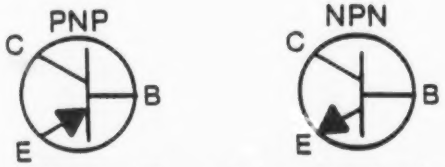
Symbol

Reference Designation for LED: DS

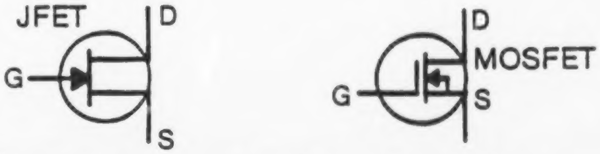
TRANSISTORS



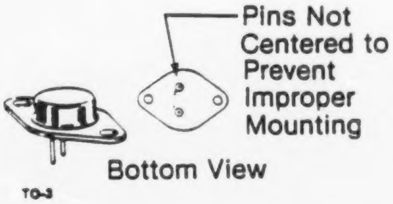
Small Signal Transistor



Bipolar Transistor Symbols

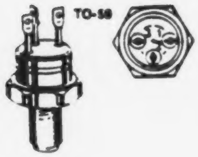


Field Effect Transistor Symbols



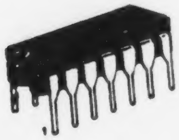
Power Transistor

Symbols
(Same as above)

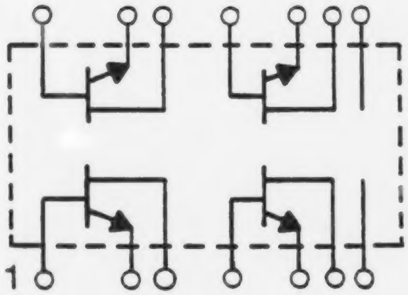


Stud Mounted Power Transistor

Symbols
(Same as above)



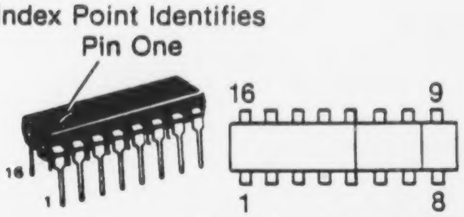
PC Mounted Transistor Array



Symbol

Reference Designation for all Transistors: Q

INTEGRATED CIRCUITS

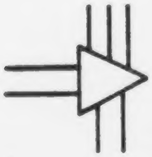


(Note Numbering of Pins)

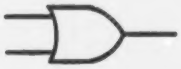
DIP IC

May come with 8, 14, 16, 22, or additional pin leads.

On Wiring Diagram

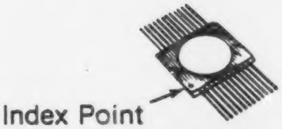


Example of an Analog Symbol



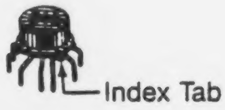
Example of a Digital Symbol

On Schematic



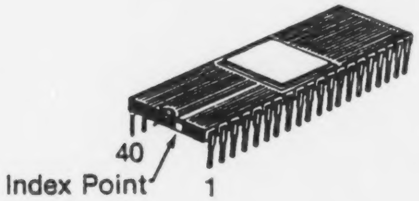
Flat IC

Symbols
(Same as above)



TO-5 Metal Can IC

Symbols
(Same as above)

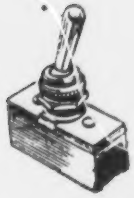


Microprocessor IC

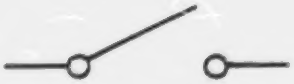
Reference Designation for all Integrated Circuits: U

SWITCHES

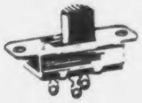
Symbols*



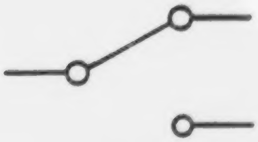
Toggle Switch



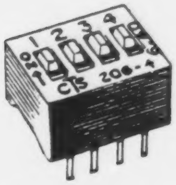
(SPST)
Single Pole
Single Throw



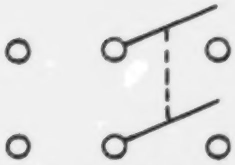
Slide Switch



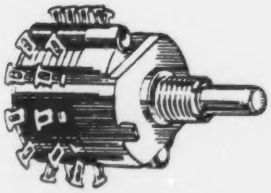
(SPDT)
Single Pole
Double Throw



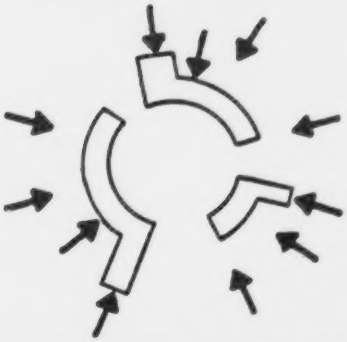
DIP Switch



(DPDT)
Double Pole
Double Throw



Rotary Switch



Rotary Wafer Switch

*Symbols show internal working of the various switches.

Reference Designation for all Switches: S

REFERENCE DESIGNATIONS

Class Letter (Relay)

Number (For Multiple Parts of the Same Class)

K1A-5

Terminal (Number or Letter)

Suffix Letter (Element of a Relay Contact)

Examples:

Third Capacitor

C3

Capacitor

14th Amplifier

AR14

Amplifier

Reference Designation Located in *ANSI Y32.16-1975.*

REFERENCE DESIGNATION CLASS LETTERS

This alphabetical listing of class designation letters is used in the assignment of reference designations for electronic and electronics parts and equipment as described in ANSI Y32.16-1975.

Parts not specifically included in this list should be assigned to the part or class most similar in function.

Designations for general classes of parts are marked with an asterisk (*) to facilitate designation of parts not specifically included in this list.

A*
accelerometer
assembly, separable or repairable (2)
circuit element, general
computer
divider, electronic
facsimile set
generator, electronic function
integrator
modulator
multiplier, electronic
recorder, sound
recording unit
reproducer, sound
servomechanism, positional
sensor (transducer to electric power)
subassembly, separable or repairable
telephone set
telephone station
teleprinter
teletypewriter

AR
amplifier (magnetic, operational or summing)
repeater, telephone

AT
attenuator (fixed or variable)
bolometer
capacitive termination
inductive termination
isolator (nonreciprocal device)
pad
resistive termination

B
blower
fan
motor
synchro

BT
barrier photocell
battery
blocking layer cell
cell, battery
cell, solar
transducer, photovoltaic

C
capacitor
capacitor bushing

CB
circuit breaker

CP
adapter, connector
coupling (aperture, loop or probe)
junction (coaxial or waveguide)

CR
absorber, overvoltage
current regular (semiconductor device)
demodulator, diode-type ring
detector, crystal
diode (capacitive, storage or tunnel)
modulator, diode-type ring
photodiode
rectifier (metallic or diode)
selenium cell (rectifier)
semiconductor device, diode
thyristor (semiconductor diodetype)
transducer, photoconductive
varactor
varistor, asymmetrical

DC
coupler, directional

DL
delay function
delay line
slow wave structure

DS
alarm, visual
annunciator
audible signalling device
bell, electronic
buzzer
device, indicating (excluding meter or thermometer)
flasher (circuit interrupter)
indicator (excluding meter or thermometer)
lamp (cold cathode, fluorescent, glow, incandescent, indicating, pilot, signal, neon)
light source, general
ringer, telephone
signal light
siren
sounder, telegraph
vibrator, indicating
visual signalling device

E*
antenna, loop or radar
arrester, lighting
bimetallic strip
brush, electrical contact

carbon block
cell (aluminum or electrolytic)
cell, conductivity
contact, electronic
core (adjustable tuning, electromagnetic, inductor, memory, transformer)
counterpoise, antenna
dipole antenna
ferrite bead rings
film element
gap (horn, protective or sphere)
Hall element or generator
insulator
magnet, permanent
part, miscellaneous electronic
post, binding
protector (network, gap, telephone)
rotary joint (microwave)
shield (electronic or optical)
short (coaxial transmission)
spark gap
splice
terminal (individual)
terminal, circuit
termination, cable
valve element

EQ
equalizer
network, equalizing

F
fuse
fuse cutout
limiter, current (for power cable)

FL
filter

G
amplifier, rotating (regulating generator)
chopper, electronic
exciter (rotating machine)
frequency changer (rotating)
generator
magneto (ignition or telephone)
regulating generator
vibrator, interrupter

H*
hardware (common fasteners, etc.)

HP*
hydraulic part

HR
heater
lamp (heating or infrared)
resistor, heating

HS
handset
operator's set

HT
earphone
headset, electronic
receiver (hearing-aid or telephone)

HY
circulator
hybrid coil (telephone usage)
junction, hybrid
magic T
network, hybrid circuit

J
connector, receptacle, electronic
disconnecting device (connector receptacle)
jack
receptacle (connector, stationary portion)
waveguide flange (choke)

K
contactor (magnetically operated)
relay (armature, solenoid, reed, thermal)

L
choke coil
coil (all not classified as transformers)
electromagnetic actuator
field (generator or motor)
inductor
inductor, shunt
reactor
saturable reactor
solenoid, electronic
winding

LS
horn, electronic
loudspeaker
loudspeaker-microphone
reproducer, sound
transducer, underwater sound

M
clock
coulomb accumulator
counter, electronic
gage
instrument
meter
oscillograph
oscilloscope
outdoor metering device
recorder, elapsed-time
strain gage
thermometer
timer, electric

MG
converter (rotating machine)
dynamotor
inverter (motor-generator)
motor-generator

MK
hydrophone
microphone
transmitter, telephone

MP*
brake
clutch
frame
gyroscope
interlock, mechanical
mechanical part
mounting (not electronic circuit, not a socket)
part, miscellaneous mechanical (bearing, coupling, gear, shaft)
part, structural
reed, vibration
tuning fork

MT
detector, primary
transducer (measuring or mode)

N
subdivision, equipment

P
connector plug, electronic
disconnecting device (connector, plug)
plug (connector, movable portion)
waveguide flange (plain)

PS
invertor, static (dc to ac)
power supply
rectifier (complete power supply assembly)
thermogenerator

PU
eraser, magnetic
erasing head
head (with various modifiers)
pickup
recording head

Q
transistor
rectifier, semiconductor controlled
switch, semiconductor controlled
thyratron (semiconductor device)
thyristor (semiconductor triode)

R
magnetoresistor
potentiometer
resistor (adjustable, nonlinear, variable)
rheostat
shunt (instrument or relay

RE
receiver, radio

RT
ballast (lamp or tube)
lamp, resistance
resistor (current-regulating or thermal)
temperature-sensing element
thermistor

RV
resistor, voltage sensitive
varistor, symmetrical

S
contractor (manually, mechanically or thermally operated)
dial, telephone
disconnecting device (switch)
governor (electronic contact type)
interlock, safety, electronic
key-switch (telephone usage)
key, telegraph
speed regulator (electrical contact type)
switch
switch (hook, interlock, reed)
thermal cutout (circuit interrupter)
thermostat

SQ
link (fusible or sensing)
squib (electric, explosive, igniter)

SR
slip ring
ring, electronic contact
rotating contact

T
autotransformer
coil (telephone induction or repeating)
coupler, linear
taper (coaxial or waveguide)
transformer (current or potential)

TB
block, connecting
strip, terminal
terminal board
test block

TC
thermocouple
thermopile

TP
test point

TR
transmitter, radio

U*
integrated circuit package
microcircuit
micromodule
nonrepairable assembly
photon-coupled isolator

V
cell (light-sensitive, photoemissive, photosensitive)
counter tube (Geiger-Muller or proportional)
detector, nuclear-radiation (gas filled)
electron tube
ion-diffusion device
ionization chamber
klystron
magnetron
phototube
photoelectric cell
resonator tube (cavity-type)
thyraton (electron tube)
traveling-wave-tube
voltage regulator (electron tube)

•

VR
diode, breakdown
regulator, voltage (excluding electron tube)
stabistor
voltage regulator
(semiconductor device)

W
bus bar
cable
cable assembly (with connectors)
cable, coaxial conductor
dielectric path
distribution line
Goubau line
transmission line
transmission line, strip-type
waveguide
wire

WT
tiepoint, wiring

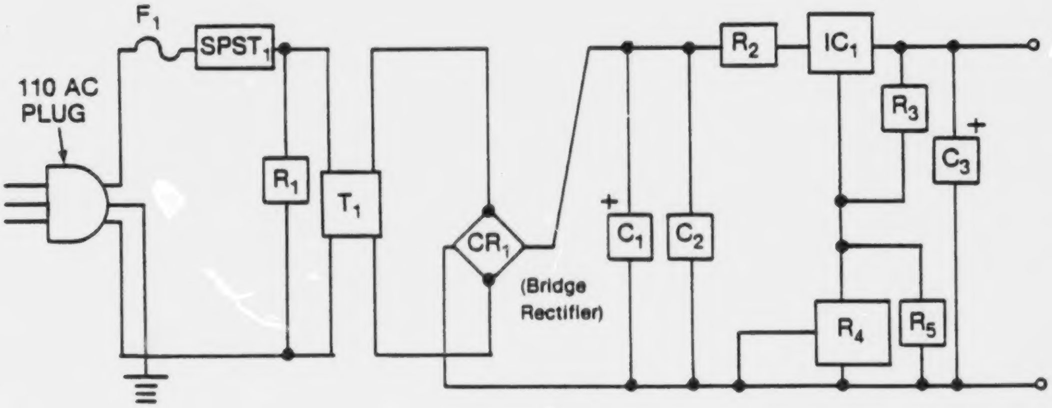
X
fuseholder
lampholder
socket

Y
crystal unit (piezoelectric or quartz)
oscillator (excluding electron tube)
oscillator, magneto-striction
resonator, tuning-fork

Z
artificial line (other than delay line)
balun
carrier-line trap
cavity, tuned
discontinuity (usually coaxial or waveguide transmission use)
gyrator
mode suppressor
network, general (where specific class letters do not fit)
network, phase-changing
resonator (tuned cavity)
shifter, directional phase (non-reciprocal)
shifter, phase
tuned circuit
tuner (E-H, multistub, slide-screw)

DRAW A SCHEMATIC DIAGRAM

Directions: On appropriate media draw the regulated power supply schematic diagram below. In the place of each box, draw the appropriate symbol using an electronic schematic template. Include the reference designator for each symbol.



MODULE: INTRODUCTION TO PRODUCTION/MANUFACTURING DRAFTING

UNIT I: INTRODUCTION TO ELECTRONIC DRAWINGS

ANSWERS TO ASSIGNMENT SHEET

AS 1.1 - Evaluated to the satisfaction of the instructor

MODULE: INTRODUCTION TO PRODUCTION/MANUFACTURING DRAFTING

UNIT I: INTRODUCTION TO ELECTRONIC DRAWINGS

UNIT TEST

Match the terms on the right with the correct definitions on the left.

____ 1. A single electrical device

____ 2. A graphical representation of a component

____ 3. A type of variable resistor

____ 4. Negative end of a diode

____ 5. Positive end of a diode

____ 6. Tool used to help remove an integrated circuit

____ 7. Metal configuration used to absorb and dissipate heat

____ 8. A letter or group of letters and numbers that identify both the symbols and the components they represent on the schematic

____ 9. A standard coding system, using colors, to indicate the electronic values of resistors and capacitors

____ 10. A method of coding used to locate the leads or pins of an electronic component

a. Reference designation

b. Heat sink

c. Anode

d. Component

e. Color code

ab. Indexing

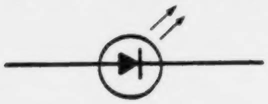
ac. Extractor

ad. Symbol

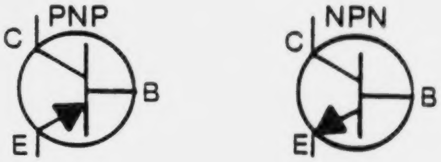
ae. Cathode

bc. Potentiometer

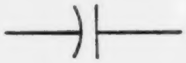
11. **Identify the following component symbols.**



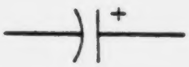
a. ______________________________



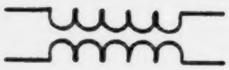
b. ______________________________



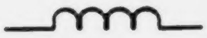
c. ______________________________



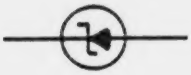
d. ______________________________



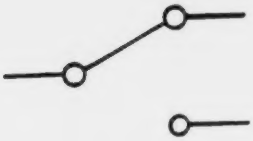
e. ______________________________



f. ______________________________



g. ______________________________



h. ______________________________

12. **Complete the following chart of abbreviations.**

a. Resistor - ________________

b. Potentiometer - ____________

c. Printed circuit - ____________

d. ____________________________ - PCB

e. ____________________________ - DIP

f. ____________________ - CAP

g. Transformer - ____________

h. _______________ - XSTR

i. Rectifier - ____________

j. Integrated circuit - ____________

k. ____________________________ - SPST

l. ____________________________ - SPDT

m. ____________________________ - DPDT

n. ____________________ - CONN

13. **Complete the following chart of reference designation class letters.**

a. _______________ - R

b. Capacitor - ______

c. Inductor - ______

d. _______________ - T

e. _______________ - CR

f. Zener diode - ____________

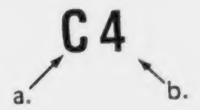
g. Light emitting diode - ____________

h. Transistor - __________

i. ______________________________ - U

j. ________________ - S

14. **Identify information about a component using reference designations.**



a. ______________________________ b. ______________________________

TM 2.1

ENGINEERING CHANGE NOTICE

NO. AN

DATE ISSUED: CONT. ON SHEET SHEET NO.

APPARATUS:

SERIES AN NO ☐ YES ☐ FINAL ☐

AR NO. REQ

ENG. PROD. PLAN AFFECTED ☐ NOT AFFECTED ☐

PREVIOUS SERIES AN:

CLASS OF CHG. · 1 EMERGENCY · 2 MEET SPEC. 3 EXC'D SPEC. · 4 NEW MODEL

IT.	NAME OF PART	DWG. NO.	REV	UNITS AFFECTED	SERIAL NOS.

REASON FOR CHANGE/PROBLEM

SUMMARY OF CHANGE/SOLUTION

STATUS OF MATERIAL:

TMBS		MDBS		RTBS	

SERIAL NUMBERS TO BE REWORKED

PROGRAMMING AFFECTED NO ☐ YES ☐ DIAGNOSTICS AFFECTED NO ☐ YES ☐ PGMS.

PRODUCT SERVICE INFORMATION

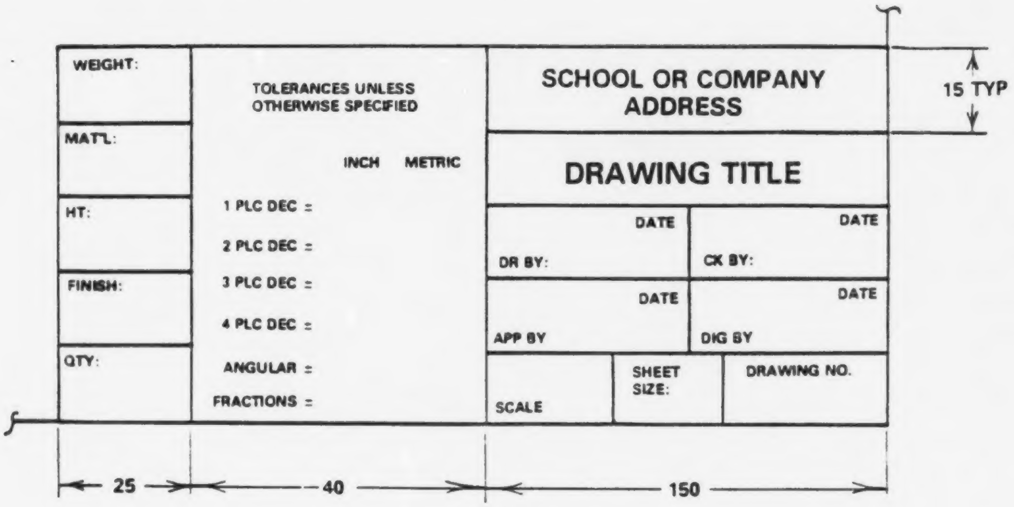
DOCUMENTATION IS AFFECTED ☐ NOT AFFECTED ☐

EQUIP. CHANGE IS MANDATORY ☐ NOT AFFECTED ☐

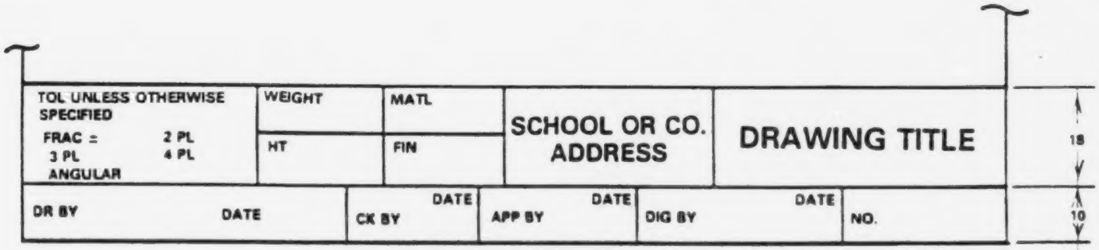
SPARE PARTS ARE AFFECTED ☐ NOT AFFECTED ☐

ISSUED BY:	DATE:	APPROVALS:	DIST. KEY		
APPROVED BY:	DATE:				

TITLE FORMS



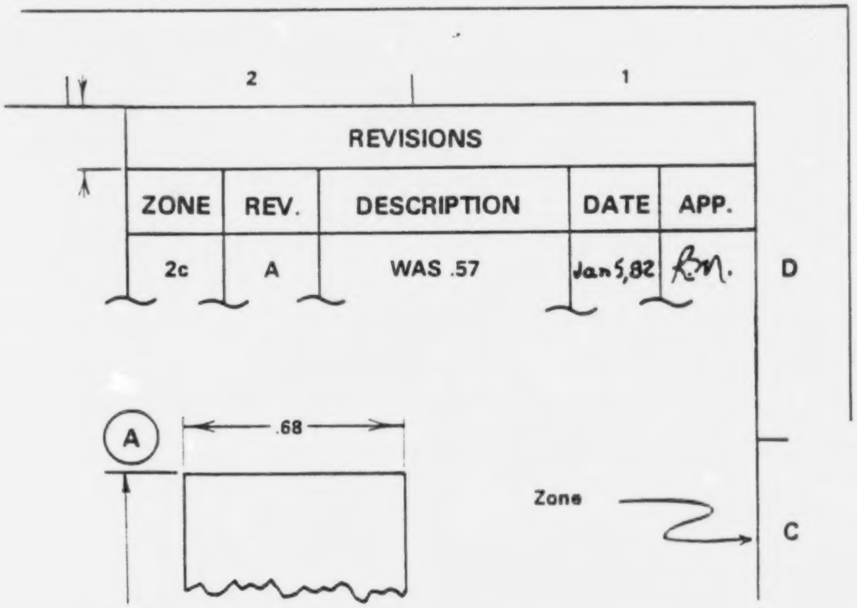
Title Block



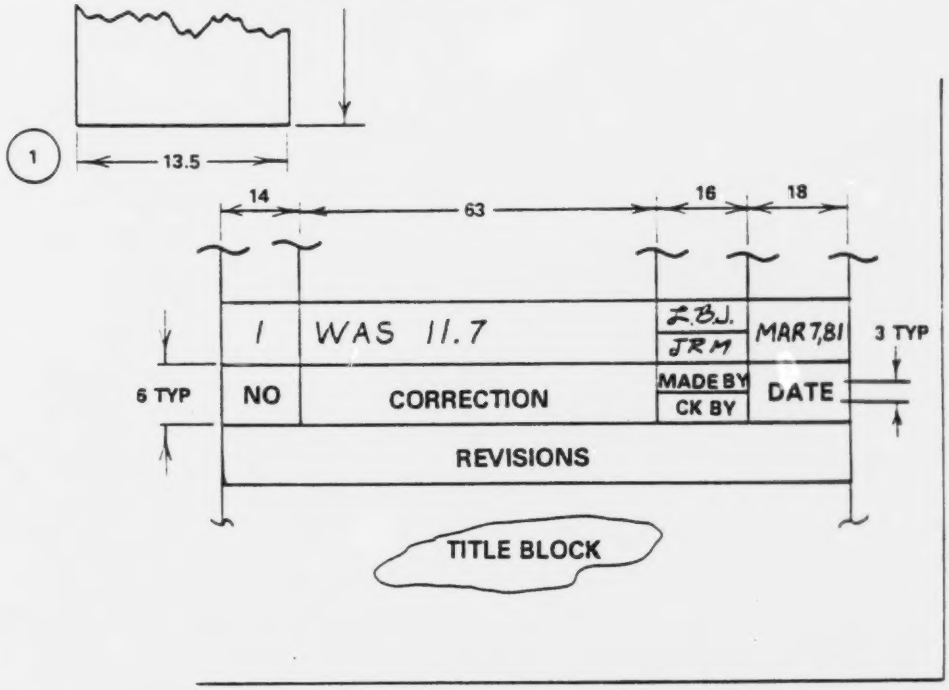
Title Strip

(NOTE: All lettering is 3mm high except Title and Drawing numbers which are 6mm high.)

REVISIONS

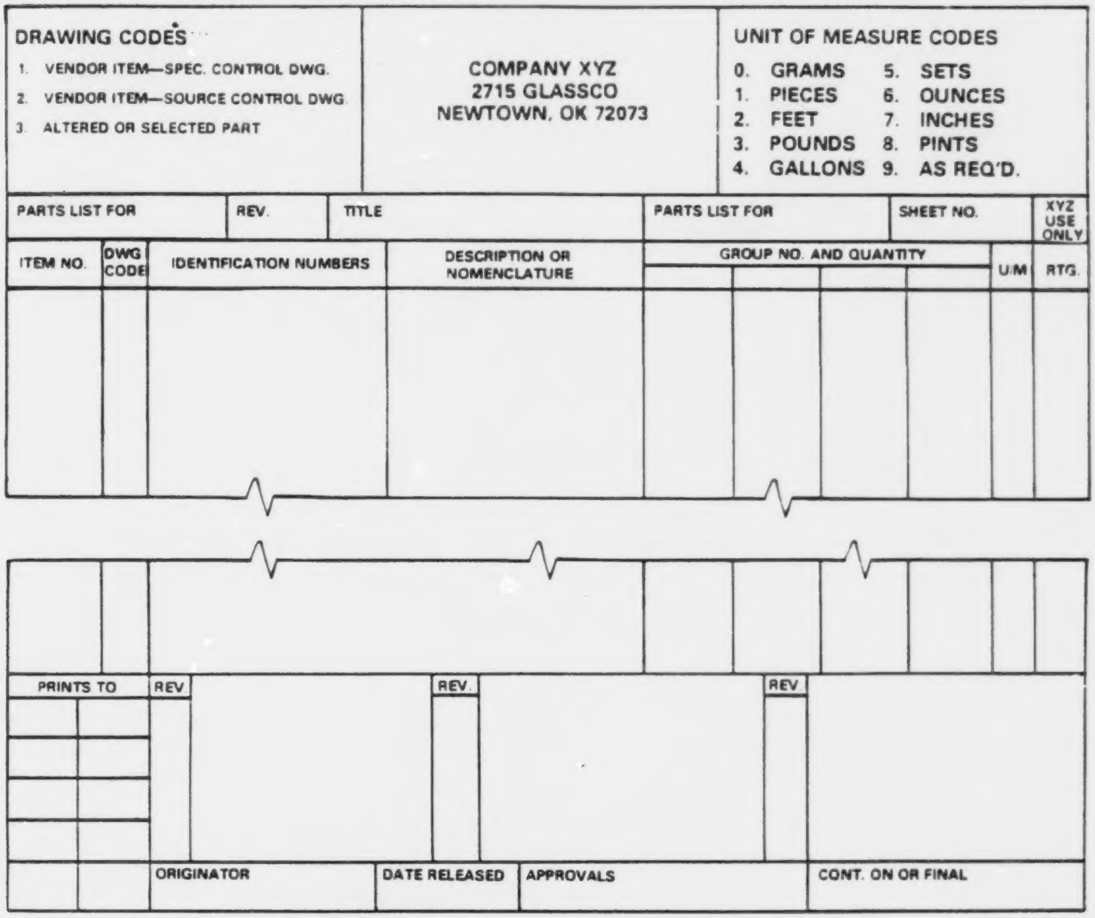


Revision Form With Zones



Revision Form Without Zones

BILL OF MATERIALS/PARTS LIST



DRAWING CODES
1. VENDOR ITEM—SPEC. CONTROL DWG.
2. VENDOR ITEM—SOURCE CONTROL DWG.
3. ALTERED OR SELECTED PART

COMPANY XYZ
2715 GLASSCO
NEWTOWN, OK 72073

UNIT OF MEASURE CODES

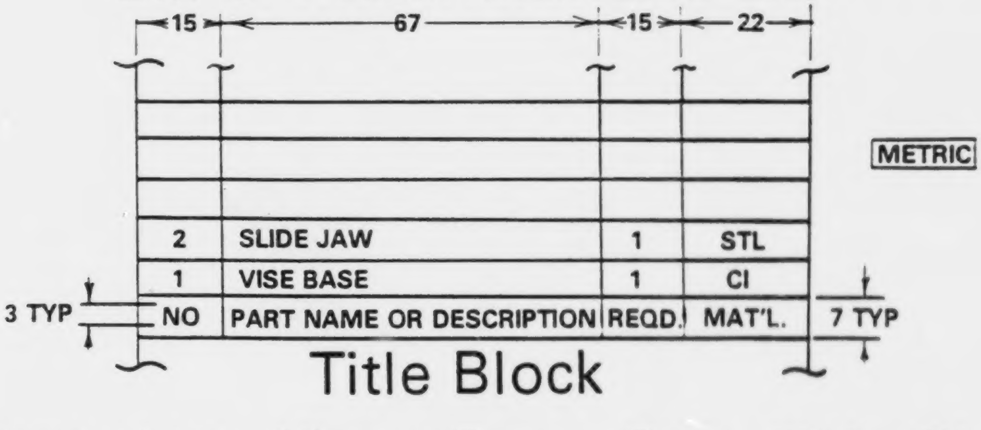
0.	GRAMS	5.	SETS
1.	PIECES	6.	OUNCES
2.	FEET	7.	INCHES
3.	POUNDS	8.	PINTS
4.	GALLONS	9.	AS REQ'D.

PARTS LIST FOR	REV.	TITLE	PARTS LIST FOR	SHEET NO.	XYZ USE ONLY

ITEM NO.	DWG CODE	IDENTIFICATION NUMBERS	DESCRIPTION OR NOMENCLATURE	GROUP NO. AND QUANTITY				U/M	RTG.

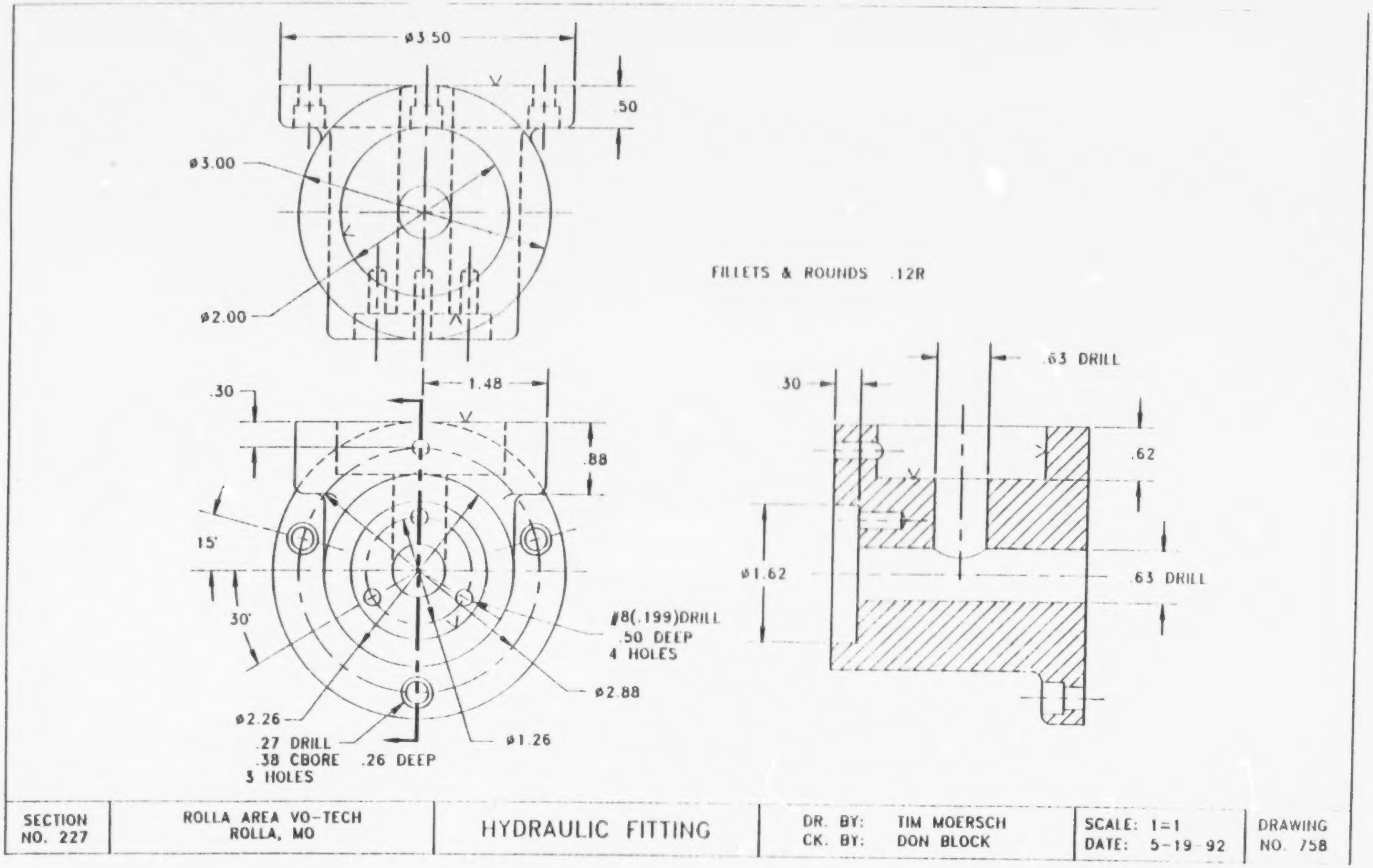
PRINTS TO		REV		REV.		REV.	
		ORIGINATOR	DATE RELEASED	APPROVALS		CONT. ON OR FINAL	

Bill of Materials/Parts List



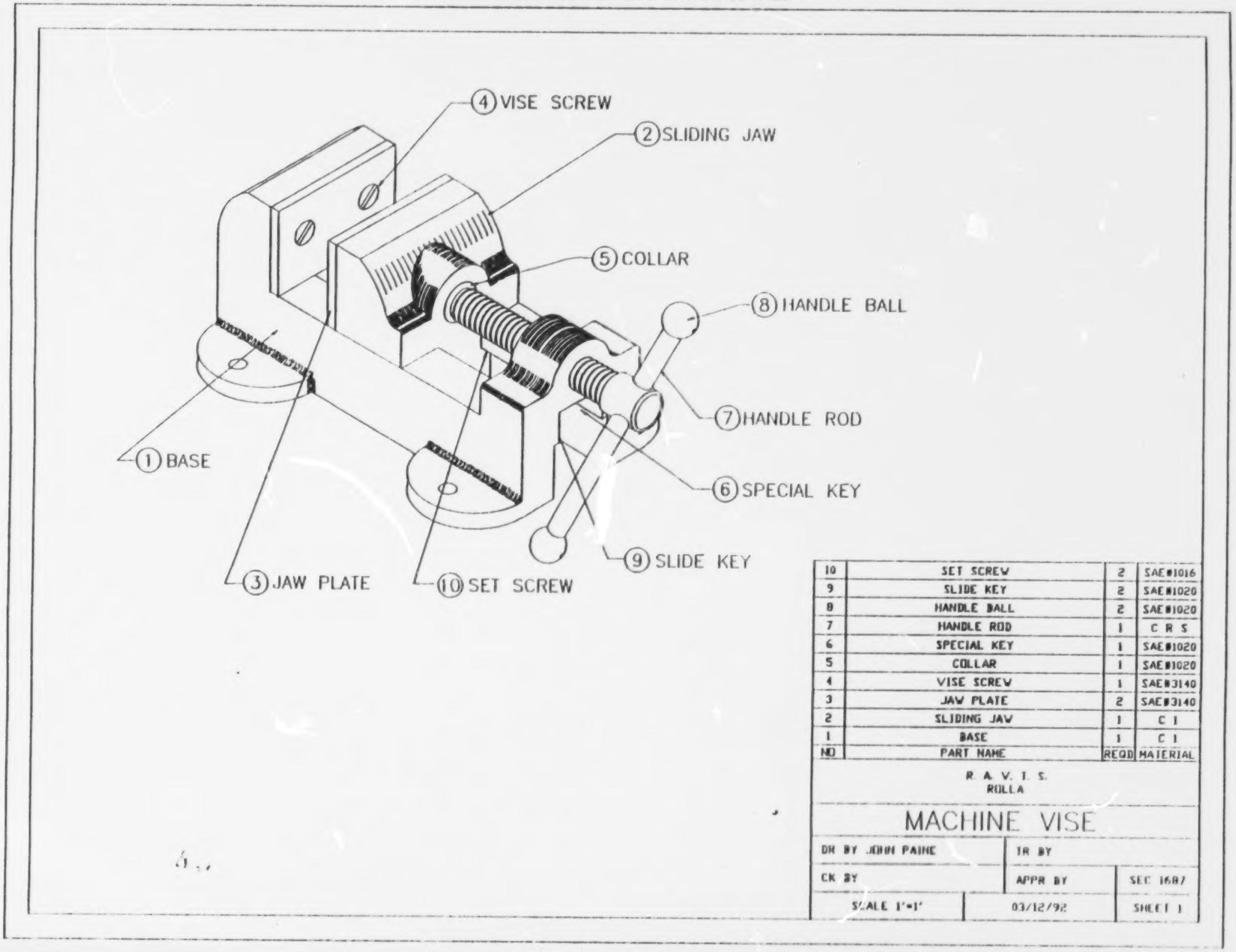
Parts List--Short Form Over Title Block

DETAIL DRAWING



TM 2.5

ASSEMBLY DRAWING



NO	PART NAME	REQD	MATERIAL
10	SET SCREW	2	SAE#1016
9	SLIDE KEY	2	SAE#1020
8	HANDLE BALL	2	SAE#1020
7	HANDLE ROD	1	C R S
6	SPECIAL KEY	1	SAE#1020
5	COLLAR	1	SAE#1020
4	VISE SCREW	1	SAE#3140
3	JAW PLATE	2	SAE#3140
2	SLIDING JAW	1	C I
1	BASE	1	C I

R. A. V. T. S.
ROLLA

MACHINE VISE

DR BY JOHN PAINE
TR BY
CK BY
APPR BY
SEC 1687
SCALE 1'=1'
03/12/92
SHEET 1

TM 2.6

DRAW A DESIGN LAYOUT

Directions: For the project assigned by your instructor, sketch the desired layout to include standard parts and fixed dimensions. Tape drawing media to drawing surface, and draw your design layout. Letter in information in its proper place, using correct lettering techniques.

DRAW A SET OF DETAIL DRAWINGS

Directions: Using the design layout of the project from AS 2.1, sketch each detail to include proper placement of dimensions, tolerances, and notes. Tape drawing media to drawing surface, and draw each detail on a separate sheet of paper of appropriate size. Letter in information in its proper place, using correct lettering techniques.

AS 2.3

DRAW AN ASSEMBLY DRAWING

Directions: For this assignment, use details from either AS 2.2 or a different project appropriate to time. Sketch an assembly drawing to include appropriate sections, views, and dimensions. Tape drawing media to drawing surface, and draw an assembly drawing. Lettering in information in its proper place, using correct lettering techniques.

COMPLETE A DETAILED TITLE BLOCK AND REVISION BLOCK

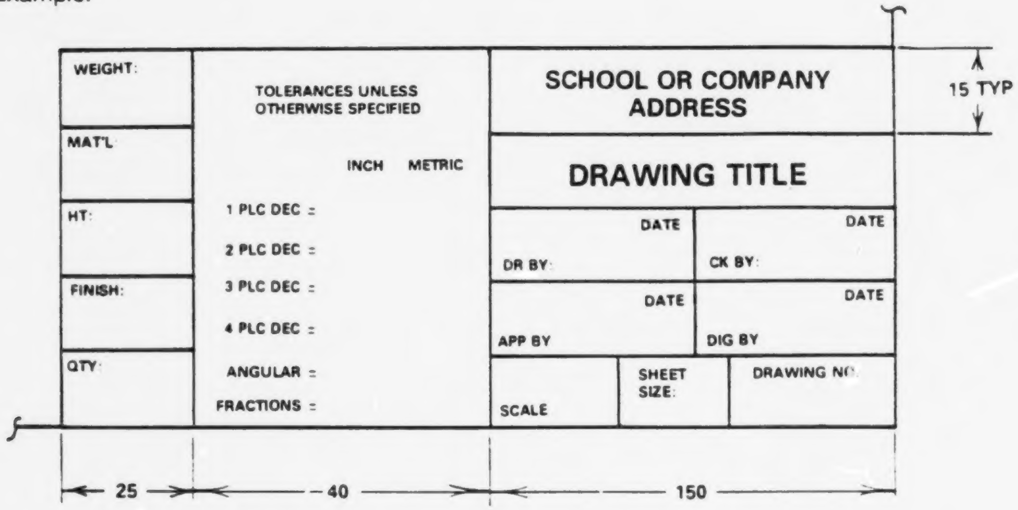
Directions: With a lettering guide and the drawing media from AS 2.2 and 2.3, use the procedure in the following example to complete a detailed title block and revision block.

Example:

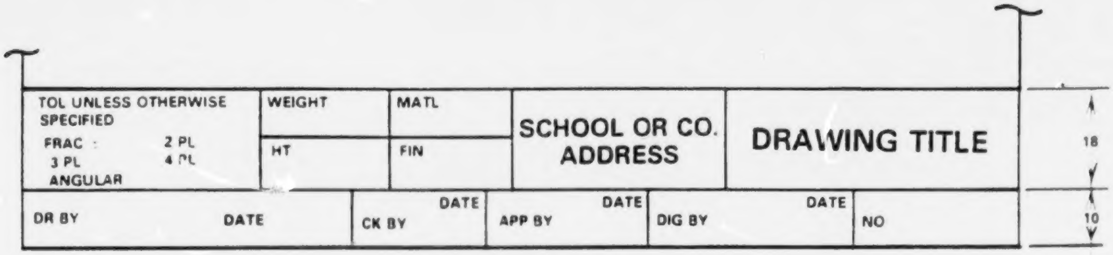
1. Tape drawing media to drawing surface.
2. Select correct pencils.
3. Select appropriate title block for detail information.

   NOTE: Refer to the following examples of title strips and title blocks. Select one shown or devise one of your own which has been approved by the instructor.

Example:



NOTE: This title block can be used with "C," "D," and "E" size sheets.



NOTE: This title block can be used with "A" and "B" size sheets.

4. Draw title block in lower right hand corner.
5. Draw guidelines for lettering.
6. Letter in information in its proper place, using correct lettering techniques.
7. Select revision block containing zone reference.
8. Draw revision block in upper right hand corner.
9. Letter in information in its proper place, using correct lettering techniques.

COMPLETE A PARTS LIST

Directions: Tape either the drawing from AS 2.3 or a separate parts list (PL) form on drawing surface. Draw a parts list. Letter in information in the parts list, using correct lettering techniques.

MODULE: INTRODUCTION TO PRODUCTION/MANUFACTURING DRAFTING

UNIT I: INTRODUCTION TO ELECTRONIC DRAWINGS

ANSWERS TO UNIT TEST

1. d (L, 1-2)
2. ad (L, 1-2)
3. bc (L, 1-2)
4. ae (L, 1-2)
5. c (L, 1-2)
6. ac (L, 1-2)
7. b (L, 1-2)
8. a (L, 1-2)
9. e (L, 1-2)
10. ab (L, 1-2)

11. (L, 1-2)
    a. Light emitting diode (LED)
    b. Bipolar transistors
    c. Fixed capacitor
    d. Polarized capacitor
    e. Transformer (without magnetic core)
    f. Inductor
    g. Zener diode
    h. Single pole double throw switch

12. (L, 1-2)
    a. RES
    b. POT
    c. PC
    d. Printed circuit board
    e. Dual in-line package
    f. Capacitor
    g. XFMR
    h. Transistor
    i. RECT
    j. IC
    k. Single pole single throw switch
    l. Single pole double throw switch
    m. Double pole double throw switch
    n. Connector

13. (L, 1-2)
    a. Resistor
    b. C
    c. L
    d. Transformer
    e. Diode
    f. VR
    g. DS
    h. Q
    i. Integrated circuit
    j. Switch

14. (L, 1-2)
    a. Capacitor
    b. Fourth (This is the fourth capacitor)

MODULE: INTRODUCTION TO PRODUCTION/MANUFACTURING DRAFTING

UNIT II: INTRODUCTION TO MACHINE DRAWINGS

UNIT OBJECTIVES

After completion of this unit, the student should be able to draw a design layout and draw a set of working drawings. In addition, the student should be able to illustrate dimensioning tolerances. Also, the student should be able to identify fasteners and symbols; construct thread symbols; construct bolts, screws and nuts; construct an assembly containing various fasteners; and construct keys in assembled positions. This knowledge will be evidenced by correctly performing the procedures outlined in the assignment sheets and by scoring ____ percent on the unit test.

SPECIFIC OBJECTIVES

Lesson 1: Layouts and Working Drawings

2.1 Match terms related to layouts and working drawings with the correct definitions.

2.2 Distinguish between standard and additional information on a title form.

2.3 Identify information on a revision block.

2.4 List information on a bill of materials/parts list.

2.5 Name the three standard parts of a detail drawing.

2.6 Match parts of an assembly drawing with the correct functions.

2.7 Demonstrate the ability to:

   a. Draw a design layout. (AS 2.1)

   b. Draw a set of detail drawings. (AS 2.2)

   c. Draw an assembly drawing. (AS 2.3)

   d. Complete a detailed title block and revision block. (AS 2.4)

   e. Complete a parts list. (AS 2.5)

Lesson 2: Dimensioning and Tolerancing

2.8 Match terms related to dimensioning and tolerancing with the correct definitions.

2.9 Distinguish between size and location dimensions for a geometric shapes.

2.10 Select mating dimensions in an assembly drawing.

2.11 Select standard machine manufactured features.

2.12 Identify proper dimension notes for standard manufactured features.

2.13 Identify systems of dimensioning tolerances on drawings.

2.14 Select true statements concerning numerical control dimensioning.

2.15 Distinguish between different fits for inch units.

2.16 Calculate limits in inch units using basic hole system.

2.17 Calculate limits in inch units using basic shaft system.

2.18 Demonstrate the ability to:

  a. Write proper dimension notes for standard machine manufactured features. (AS 2.6)

  b. Dimension an object completely (AS 2.7).

  c. Calculate and dimension clearance fit tolerances using standard fit tables. (AS 2.8)

  d. Calculate and dimension interference fit tolerances using standard fit tables. (AS 2.9)

  e. Calculate and assign tolerances to mating parts using standard fit tables. (AS 2.10)

Lesson 3: Fasteners and Hardware

2.19 Match terms related to fasteners and hardware with the correct definitions.

2.20 Name two general types of fasteners.

2.21 Name three basic applications of screw threads.

2.22 Identify screw thread nomenclature.

2.23 Identify screw thread profiles.

2.24 Compute lead of thread.

2.25 Identify screw thread symbols.

2.26 Match classes of fit for unified threads with the correct uses.

2.27 Identify parts of thread notes.

2.28 Distinguish between conventional representations of pipe threads.

2.29 List types of threaded removable fasteners.

2.30 Name two shapes of bolts and nuts.

2.31 Select types of locknuts and locking devices.

2.32 Name types of standard cap screws.

2.33 Complete a list of types of machine screws.

2.34 Identify set screw heads and points.

2.35 Identify miscellaneous bolts and screws.

2.36 Select devices to lock components on a shaft.

2.37 Select types of keys to prevent relative motion between wheel and shaft.

2.38 Select true statements concerning washers.

2.39 Distinguish between types of lock washers.

2.40 Demonstrate the ability to:

  a. Construct thread symbols. (AS 2.11)

  b. Construct bolts, screws, and nuts. (AS 2.12)

  c. Construct an assembly containing various fasteners. (AS 2.13)

  d. Construct keys in assembled positions. (AS 2.14)

MODULE: INTRODUCTION TO PRODUCTION/MANUFACTURING DRAFTING

UNIT II: INTRODUCTION TO MACHINE DRAWINGS

CONTENTS OF THIS UNIT

A. Objective sheets

B. References

C. Notes to the instructor

D. Lesson plans

- 1. **Lesson 1: Layouts and Working Drawings** 49
  - a. Information outline
  - b. Transparency masters

    TM 2.1: Engineering Change Notice
    TM 2.2: Title Forms
    TM 2.3: Revisions
    TM 2.4: Bill of Materials/Parts List
    TM 2.5: Detail Drawing
    TM 2.6: Assembly Drawing

  - c. Assignment sheets

    AS 2.1: Draw a Design Layout
    AS 2.2: Draw a Set of Detail Drawings
    AS 2.3: Draw an Assembly Drawing
    AS 2.4: Complete a Detailed Title Block and Revision Block
    AS 2.5: Complete a Parts List

  - d. Answers to assignment sheets
- 2. **Lesson 2: Dimensioning and Tolerancing** 77
  - a. Information outline
  - b. Transparency masters

    TM 2.7: Types of Tolerances
    TM 2.8: Application of Dimensioning
    TM 2.9: Mating Dimensions
    TM 2.10: Hole Operations

  - c. Assignment sheets

    AS 2.6: Write Proper Dimension Notes for Standard Machine Manufactured Features

AS 2.7: Dimension an Object Completely
AS 2.8: Calculate and Dimension Clearance Fit Tolerances Using Standard Fit Tables
AS 2.9: Calculate and Dimension Interference Fit Tolerances Using Standard Fit Tables
AS 2.10: Calculate and Assign Tolerances to Mating Parts Using Standard Fit Tables

d. Answers to assignment sheets

3. **Lesson 3: Fasteners and Hardware** 121

a. Information outline

b. Transparency masters

TM 2.11: Screw Thread Nomenclature
TM 2.12: Screw Thread Profiles
TM 2.13: Screw Thread Symbols
TM 2.14: Combined Screw Thread Symbols
TM 2.15: American National Thread Note for Holes
TM 2.16: American National Thread Notes for Threaded Shaft
TM 2.17: American Standard Unified Thread Notes
TM 2.18: Removable Fasteners
TM 2.19: Locknuts and Locking Devices
TM 2.20: Standard Cap Screws
TM 2.21: Machine Screws
TM 2.22: Set Screws
TM 2.23: Miscellaneous Bolts and Screws
TM 2.24: Miscellaneous Bolts and Screws (continued)
TM 2.25: Shaft Locking Hardware
TM 2.26: Keys
TM 2.27: Washers
TM 2.28: Tooth Lock Washers

c. Assignment sheets

AS 2.11: Construct Thread Symbols
AS 2.12: Construct Bolts, Screws, and Nuts
AS 2.13: Construct an Assembly Containing Various Fasteners
AS 2.14: Construct Keys in Assembled Positions

d. Answers to assignment sheets

E. Unit test

F. Answers to unit test

REFERENCES

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NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. **Lesson 1: Layouts and Working Drawings**

    a. Select the title block that you want the students to use in this particular class, and give instructions on filling it out.

    b. Make appropriate changes in the student's drawing sheets.

2. **Lesson 2: Dimensioning and Tolerancing**

    a. Develop a display of different types of gages with corresponding parts to be measured for size and location.

    b. Have students check a group of parts for correct dimensions by using gages.

    c. Provide part drawings for students to see specified tolerances.

    d. Visit a manufacturing quality control department to see how they operate and inspect parts.

3. **Lesson 3: Fasteners and Hardware**

    a. Have students tour a hardware store, searching out various fasteners. A display of various fasteners in the classroom would improve learning of this unit.

    b. Have students tour a welding lab to see how parts are welded together.

    c. Assemble a display of various hardware items obtainable from a hardware store and discuss their possible uses.

    d. Have various springs for the students to see.

MODULE: INTRODUCTION TO PRODUCTION/MANUFACTURING DRAFTING

UNIT II: INTRODUCTION TO MACHINE DRAWINGS

LESSON 1: LAYOUTS AND WORKING DRAWINGS

I. Terms and definitions

A. **Assembly drawing**--drawing showing all parts in their working position

B. **Bill of materials/parts list**--itemized list of parts shown with an assembly drawing NOTE: Parts may be raw stock, purchased parts, or fasteners.

C. **Casting drawing**--a detail drawing of a workpiece to be cast

D. **Design layout**--accurate drawing of all parts in working positions showing clearances of moving parts, ease of assembly, and ease of serviceability

E. **Design process**--organized method to combine scientific principles, standard parts, and resources into the solution of a problem

F. **Detail assembly drawing**--combined detail and assembly drawing used when the details are simple enough for all parts to be shown and dimensioned clearly while shown in assembled positions

NOTE: This drawing is used on aircraft subassemblies, drawings of jigs and fixtures, and welding drawings.

G. **Detail drawing**--drawing containing the necessary information to completely manufacture a single part of one stage of a single part

H. **Engineering change notice (ECN)**--an approved change to a drawing caused by a change in design, tool changes, errors in design or production, and customer changes (TM 2.1)

NOTE: ECN's are reflected in the revision record on the drawing.

I. **Forging drawing**--a detail drawing of a workpiece to be forged in dies

J. **Revision form**--area to show all information related to a drawing revision

K. **Revision**--change made on a drawing

NOTE: This change may be due to drafting error, design change or error, production change or error, or customer change or error.

L. **Title form**--standardized place to show all information not shown with notes and dimensions on the drawing

M. **Title**--name of the object or project

NOTE: The title is the second most important size of lettering on the drawing.

N. **Zoning**--equal intervals along the margins labeled with numbers along the horizontal margin and with letters along the vertical margin for locating an area on a drawing

II. Information on a title form (TM 2.2)

NOTE: The following information is generally found in a title form as a title block or title strip.

A. Standard information

1. Name of the object represented
2. Name and address of the industry
3. Name and address of the client, if any
4. Number of drawings which may include sheet letter size
5. Revision letter
6. Signature of drafter with date of completion
7. Signature of checker with date of completion
8. Signature of designer, engineer, or other official and date approved
9. Predominate scale of drawing
10. Sheet number for multiple sheets

B. Additional information

1. Tolerances
2. Material
3. Heat treatment
4. Quantity
5. Finish
6. Hardness
7. Weight
8. Superseding note
9. Company logos
10. Other peculiarities of the product

III. Information on a revision block (TM 2.3)

A. Letter or number of change(s)

- B. Description of correction or change
- C. Person making change
- D. Person checking change
- E. Date of change
- F. Zone for location of change

IV. Information on a bill of materials/parts list (TM 2.4)

- A. Standard information
    1. Item number referring to assembly drawing

       NOTE: Item numbers are sometimes referred to as dash numbers.

    2. Part name
    3. Number required
    4. Material from which part is made
- B. Additional information
    1. Stock number
    2. Description or nomenclature
    3. Address of vender
    4. Unit of measure

       NOTE: These units include grams, pieces, feet, pounds, or gallons.

    5. Group subassembly where used
    6. Approval
    7. Release date
    8. Originator
    9. Revision
    10. Stock size
    11. Pattern number
    12. Weight

V. Standard parts of a detail drawing (TM 2.5)

  A. Shape description

  NOTE: This includes multiview, auxiliary, sections, and/or pictorials.

  B. Dimensions

  NOTE: These include size, location, and tolerances.

  C. Notes

  NOTE: These may be general or specific.

VI. Parts of an assembly drawing and functions (TM 2.6)

  A. Views--show relationship of parts

  NOTE: Views do not show the shapes of individual parts but just how they fit together.

  B. Sections--show the inside function or construction of the parts

  C. Hidden lines--shown only to promote clearness; unnecessary when several sections are used

  NOTE: Hidden lines may not be necessary and in some cases would only confuse the reading of the drawing.

  D. Dimensions--show maximum or minimum sizes or locations of machine parts after assembly and overall size

  NOTE: Only certain dimensions and notes are given on an assembly drawing.

  E. Parts identification numbers--allow for quick identification of physical shape and guide reader to the parts list (Figure 1)

  NOTE: An identification number should be 5mm high in a 12mm circle. The circle is connected to the part with an arrowhead, dot, or S.

  NOTE: Avoid vertical and horizontal leaders.

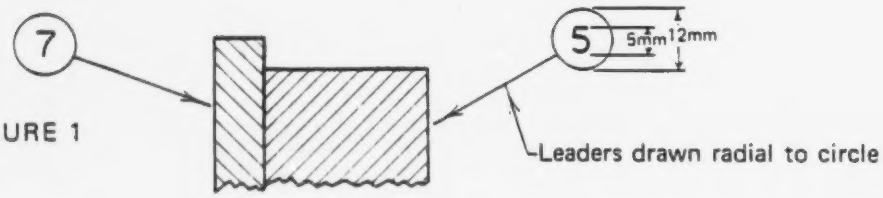


FIGURE 1

ENGINEERING CHANGE NOTICE

	NO.		AN
	DATE ISSUED:	CONT. ON SHEET	SHEET NO.
APPARATUS:	SERIES AN	NO ☐ YES ☐	FINAL ☐
	AR NO.	REQ	

ENG. PROD. PLAN AFFECTED ☐ NOT AFFECTED ☐	PREVIOUS SERIES AN:	CLASS OF CHG. - 1 EMERGENCY - 2 MEET SPEC. 3 EXC'D SPEC. - 4 NEW MODEL

IT.	NAME OF PART	DWG. NO.	REV	UNITS AFFECTED	SERIAL NOS.

REASON FOR CHANGE/PROBLEM

SUMMARY OF CHANGE/SOLUTION

STATUS OF MATERIAL:

TMBS		MDBS		RTBS	

SERIAL NUMBERS TO BE REWORKED

PROGRAMMING AFFECTED NO ☐ YES ☐	DIAGNOSTICS AFFECTED NO ☐ YES ☐ PGMS.

PRODUCT SERVICE INFORMATION

DOCUMENTATION IS AFFECTED ☐ NOT AFFECTED ☐

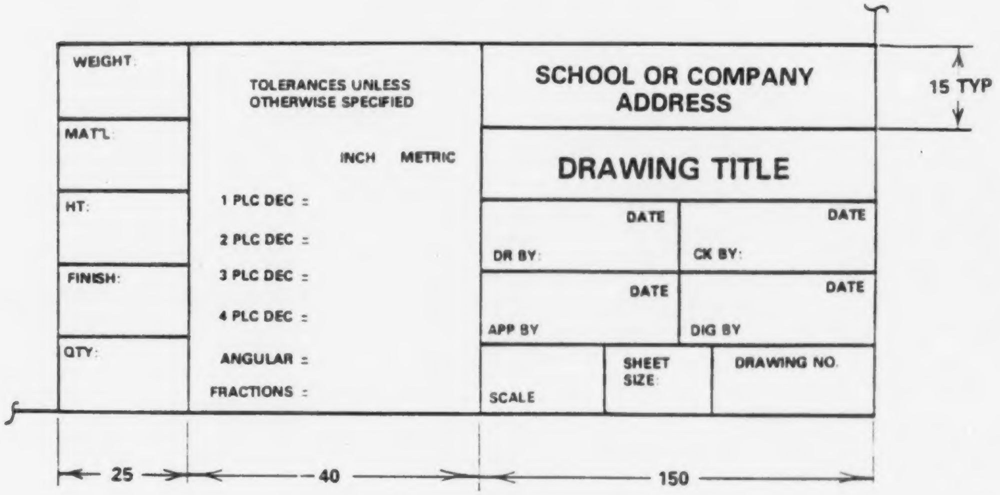
EQUIP. CHANGE IS MANDATORY ☐ NOT AFFECTED ☐

SPARE PARTS ARE AFFECTED ☐ NOT AFFECTED ☐

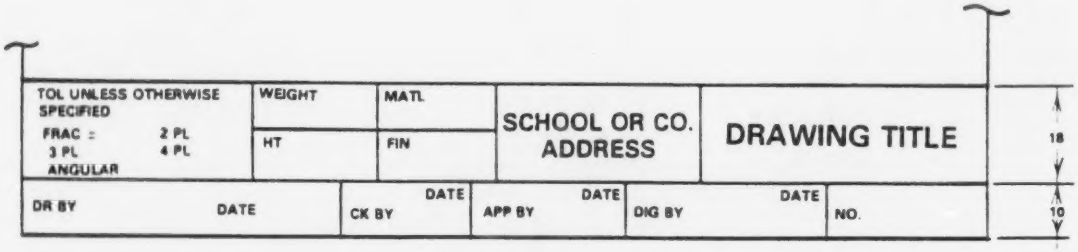
ISSUED BY:	DATE:	APPROVALS:	DIST. KEY		
APPROVED BY:	DATE:				

TM 2.2

TITLE FORMS



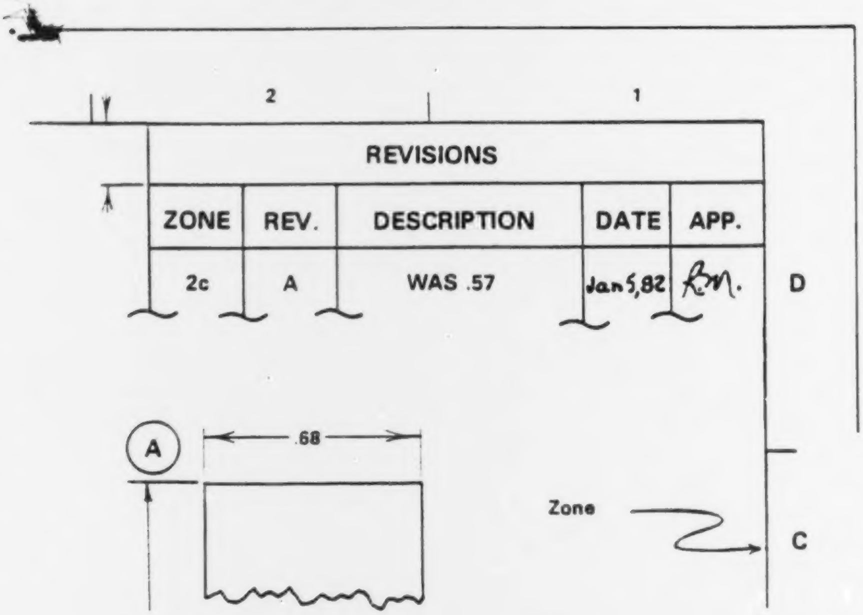
Title Block



Title Strip

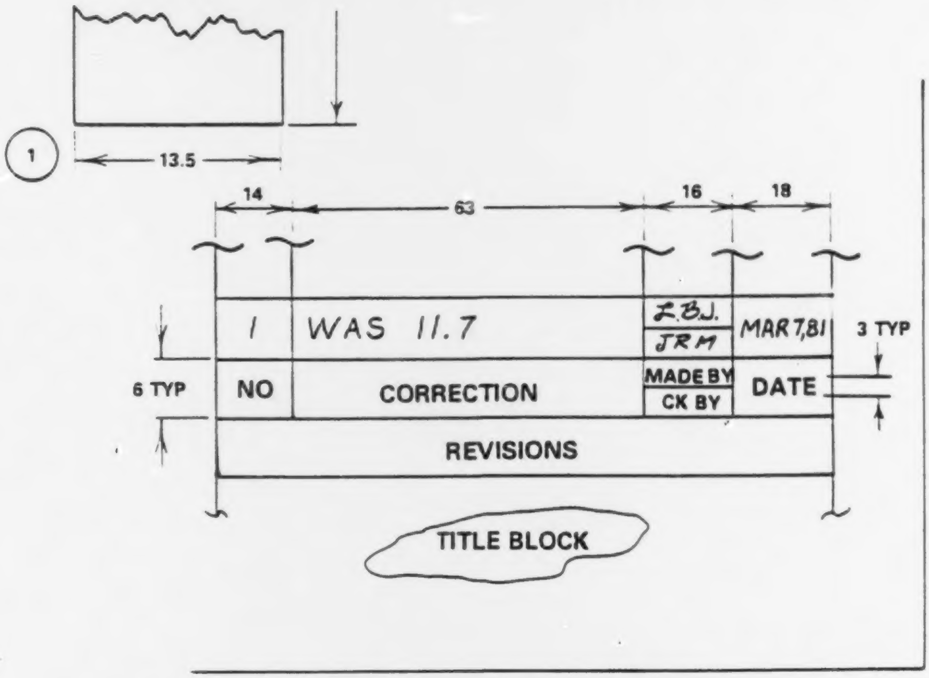
(NOTE: All lettering is 3mm high except Title and Drawing numbers which are 6mm high.)

REVISIONS



REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APP.
2c	A	WAS .57	Jan 5,82	R.M.

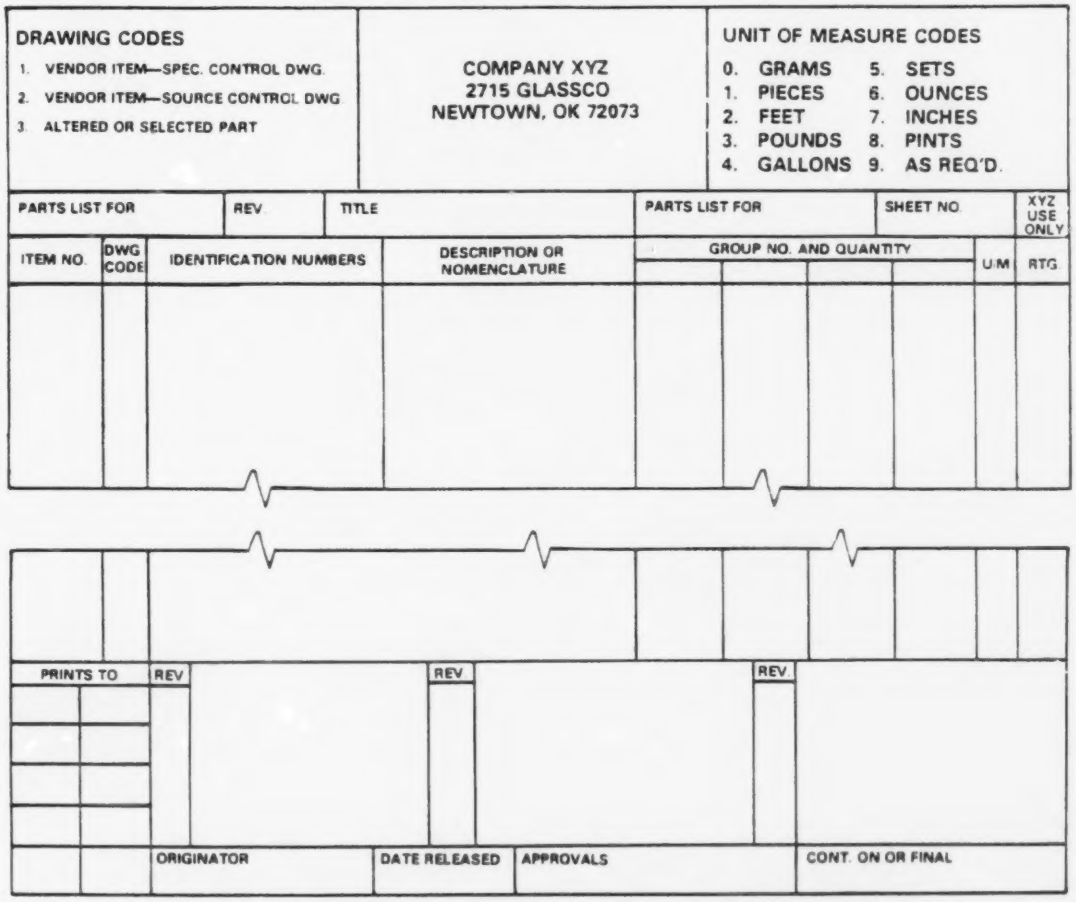
Revision Form With Zones



1	WAS 11.7	L.B.J. JRM	MAR 7,81
NO	CORRECTION	MADE BY CK BY	DATE
REVISIONS			

Revision Form Without Zones

BILL OF MATERIALS/PARTS LIST



DRAWING CODES

1. VENDOR ITEM—SPEC. CONTROL DWG.
2. VENDOR ITEM—SOURCE CONTROL DWG
3. ALTERED OR SELECTED PART

COMPANY XYZ
2715 GLASSCO
NEWTOWN, OK 72073

UNIT OF MEASURE CODES

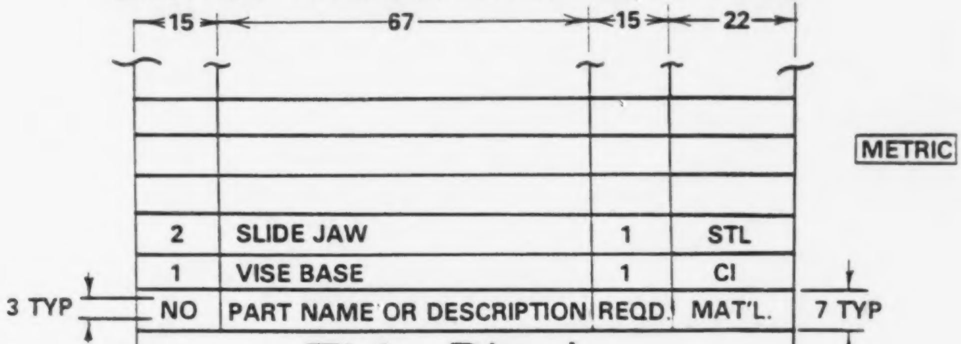
0. GRAMS
1. PIECES
2. FEET
3. POUNDS
4. GALLONS
5. SETS
6. OUNCES
7. INCHES
8. PINTS
9. AS REQ'D.

PARTS LIST FOR	REV.	TITLE	PARTS LIST FOR	SHEET NO.	XYZ USE ONLY

ITEM NO.	DWG CODE	IDENTIFICATION NUMBERS	DESCRIPTION OR NOMENCLATURE	GROUP NO. AND QUANTITY				U/M	RTG.

PRINTS TO		REV		REV		REV	
		ORIGINATOR	DATE RELEASED	APPROVALS		CONT. ON OR FINAL	

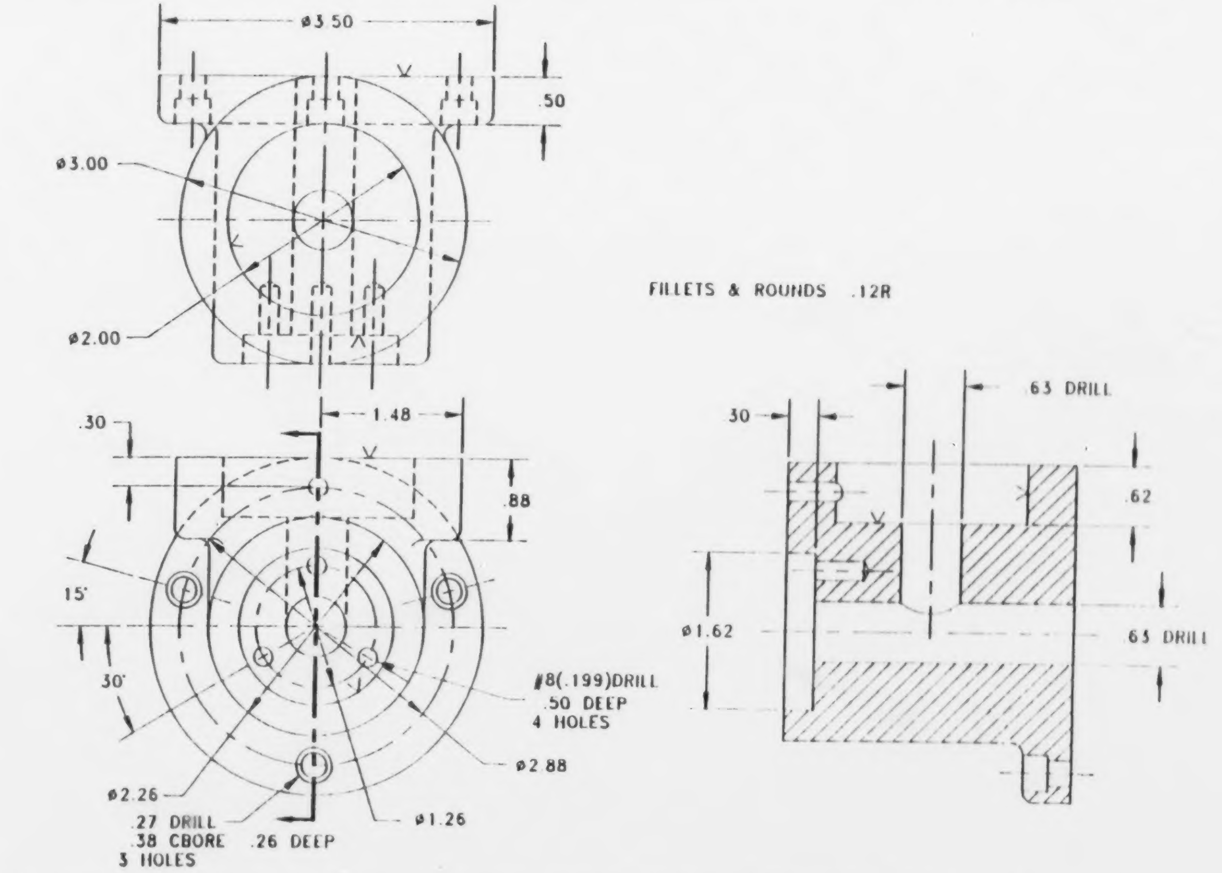
Bill of Materials/Parts List



Title Block

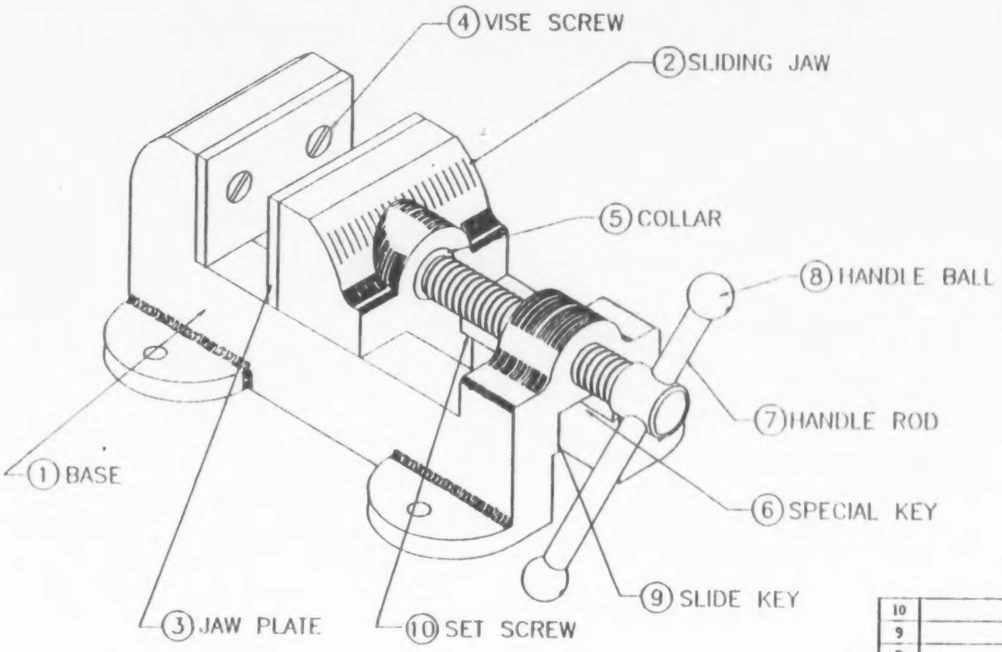
Parts List--Short Form Over Title Block

DETAIL DRAWING



SECTION NO. 227	ROLLA AREA VO-TECH ROLLA, MO	HYDRAULIC FITTING	DR. BY: TIM MOERSCH CK. BY: DON BLOCK	SCALE: 1=1 DATE: 5-19-92	DRAWING NO. 758

ASSEMBLY DRAWING



NO	PART NAME	REQD	MATERIAL
10	SET SCREW	2	SAE#1016
9	SLIDE KEY	2	SAE#1020
8	HANDLE BALL	2	SAE#1020
7	HANDLE ROD	1	C R S
6	SPECIAL KEY	1	SAE#1020
5	COLLAR	1	SAE#1020
4	VISE SCREW	1	SAE#3140
3	JAW PLATE	2	SAE#3140
2	SLIDING JAW	1	C I
1	BASE	1	C I

R. A. V. T. S.
ROLLA

MACHINE VISE

DR BY JOHN PAINE
TR BY
CK BY
APPR BY
SEC 1687
SCALE 1"=1"
03/12/92
SHEET 1

AS 2.1

DRAW A DESIGN LAYOUT

Directions: For the project assigned by your instructor, sketch the desired layout to include standard parts and fixed dimensions. Tape drawing media to drawing surface, and draw your design layout. Letter in information in its proper place, using correct lettering techniques.

AS 2.2

DRAW A SET OF DETAIL DRAWINGS

Directions: Using the design layout of the project from AS 2.1, sketch each detail to include proper placement of dimensions, tolerances, and notes. Tape drawing media to drawing surface, and draw each detail on a separate sheet of paper of appropriate size. Letter in information in its proper place, using correct lettering techniques.

DRAW AN ASSEMBLY DRAWING

Directions: For this assignment, use details from either AS 2.2 or a different project appropriate to time. Sketch an assembly drawing to include appropriate sections, views, and dimensions. Tape drawing media to drawing surface, and draw an assembly drawing. Lettering in information in its proper place, using correct lettering techniques.

AS 2.4

COMPLETE A DETAILED TITLE BLOCK AND REVISION BLOCK

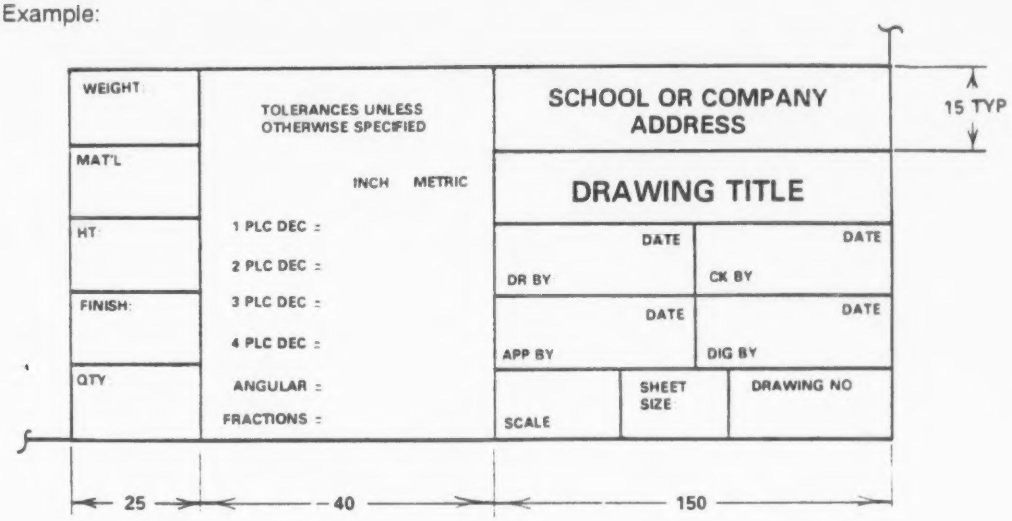
Directions: With a lettering guide and the drawing media from AS 2.2 and 2.3, use the procedure in the following example to complete a detailed title block and revision block.

Example:

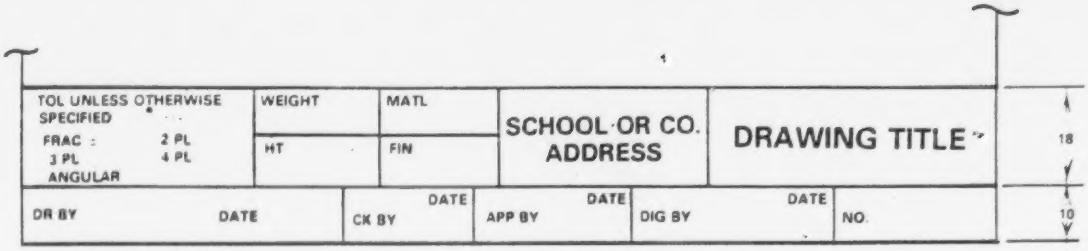
1. Tape drawing media to drawing surface.
2. Select correct pencils.
3. Select appropriate title block for detail information.

   NOTE: Refer to the following examples of title strips and title blocks. Select one shown or devise one of your own which has been approved by the instructor.

Example:



NOTE: This title block can be used with "C," "D," and "E" size sheets.



NOTE: This title block can be used with "A" and "B" size sheets.

4. Draw title block in lower right hand corner.

5. Draw guidelines for lettering.

6. Letter in information in its proper place, using correct lettering techniques.

7. Select revision block containing zone reference.

8. Draw revision block in upper right hand corner.

9. Letter in information in its proper place, using correct lettering techniques.

COMPLETE A PARTS LIST

Directions: Tape either the drawing from AS 2.3 or a separate parts list (PL) form on drawing surface. Draw a parts list. Letter in information in the parts list, using correct lettering techniques.

MODULE: INTRODUCTION TO PRODUCTION/MANUFACTURING DRAFTING

UNIT II: INTRODUCTION TO MACHINE DRAWINGS

ANSWERS TO ASSIGNMENT SHEETS

All assignment sheets are to be evaluated to the satisfaction of the instructor.

MODULE: INTRODUCTION TO PRODUCTION/MANUFACTURING DRAFTING

UNIT II: INTRODUCTION TO MACHINE DRAWINGS

LESSON 2: DIMENSIONING AND TOLERANCING

I. Terms and definitions

A. **Actual size**--the measured size of an object

B. **Allowance**--the minimum international difference in the dimensions of mating parts to provide for different classes of fits; the minimum clearance or maximum interference when parts are at maximum material condition (MMC)

C. **Anthropometric data**--measurements of the human body and its parts

D. **Basic size**--the size of a part determined by engineering and design requirements from which the limits of size are determined; the line of zero deviation

E. **Basic dimension**--a theoretically exact value used to describe the size, shape, or location of a feature

NOTE: Basic dimensions are indicated on the drawing by the word BASIC or the abbreviation BSC, or by placing dimensions in a box (see TM 2.7).

F. **Basic shaft system**--the basic size of the shaft is the design size and the allowance is applied to the hole

NOTE: The fundamental deviation for a shaft system is h.

G. **Basic size**--the measured size of an object

H. **Basic hole system**--the basic size of the hole is the design size (basic size) and the allowance is applied to the shaft

NOTE: The fundamental deviation for a hole system is H.

I. **Bilateral tolerance**--the variations permitted are in both directions from the specified dimensions

J. **Chain dimensioning**--successive dimensions that extend from one feature to another, rather than each originating at a datum

NOTE: Tolerances accumulate with chain dimensions unless the note, "Tolerances do not accumulate," is placed on the drawing.

K. **Clearance fit**--limits of size are determined so that a loose fit or positive allowance occurs between mating parts

L. **Datum dimensioning**--method where features are dimensioned individually from a datum

NOTE: System does not accumulate tolerances or dimensions from feature to feature.

M. **Datums**--points, lines, or other geometric shapes assumed to be exact from which the location or geometric form of features of a part may be established

N. **Design size**--the size of a feature after an allowance for clearance has been applied and tolerances have been assigned

O. **Dimension**--measurements given on a drawing such as size and location

P. **Feature**--a portion of a part, such as a diameter, hole, keyway, or flat surface

Q. **Fit**--degree of tightness or looseness between mating parts

R. **Form tolerances**--Maximum allowable variations of a perfect geometric shape

S. **Fundamental deviation**--the deviation nearer the basic size for the hole and near the basic size for the shaft

NOTE: The fundamental deviation is an upper case letter for holes and a lower case letter for shafts.

T. **Geometric shapes**--shapes such as prisms, cylinders, pyramids, cones, and spheres

U. **Interchangeability**--the condition that refers to a part made to limit dimensions so that it will fit any part similarly manufactured; the ability of mating parts to fit properly together

V. **Interference fit**--limits of size are determined so that a negative allowance or tight fit occurs between mating parts

W. **International tolerance grade**--group of tolerances numbered 01-16

NOTE: 01 through 5 are used for gages, 6 through 12 are used for fits, and 13 through 16 are used for general dimensioning.

X. **Lay**--direction of the major surface pattern determined by manufacturing method used

Y. **Least material condition (LMC)**--used when the least material is present in a feature

NOTE: This is the largest hole, smallest shaft.

Z. **Limit dimensioning**--method of dimensioning where only the maximum and minimum dimensions are given

AA. **Limits**--the extreme permissible dimensions of a part resulting from the application of a tolerance; the maximum and minimum size indicated by a tolerance

BB. **Location dimension**--any type of dimension that locates a feature on an object

CC. **Lower deviation**--difference between the minimum limit and the basic size

DD. **Maximum material condition (MMC)**--used when maximum material is present in a feature

NOTE: This is the smallest hole, largest shaft.

EE. **Nominal size**--the classification size given to manufactured products such as pipe or lumber

NOTE: It may or may not indicate exact size of the product.

FF. **Positional tolerance**--exact theoretical position of a feature established by basic dimensions

NOTE: The term "positional tolerancing" has the same meaning as "true position tolerancing."

GG. **Reference dimension**--untoleranced dimensions placed on drawings for the convenience of engineering and manufacturing

NOTE: Reference dimensions are indicated by the abbreviation REF.

HH. **Roughness**--fine irregularities in surface texture.

II. **Size dimension**--any type of dimension that tells how large or small an object is

KK. **Surface quality**--roughness, waviness, and lay of a surface which may include certain flaws

JJ. **Tolerance zone**--the association of a fundamental deviation (letter) with an international tolerance grade (IT number)

KK. **Tolerance**--the total amount of variation permitted in limit dimensioning of a part; the difference between the limit dimensions

LL. **Tolerancing**--system designed to control dimensions to allow interchangeability in manufacturing

MM. **Transition fit**--limits of size are determined so that the allowance may be either a clearance fit or an interference fit

NN. **Unilateral tolerance**--the variation is in only one direction from the specified dimensions

OO. **Upper deviation**--difference between the maximum limit and the basic size

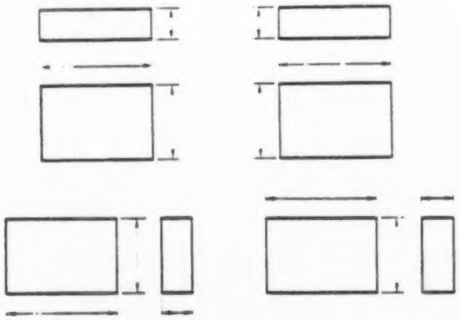
PP. **Variation**--the extent to which or the range in which a dimension or size varies

QQ. **Waviness**--widely spaced element of a surface texture

II. Size and location dimensions for geometric shapes (TM 2.8)

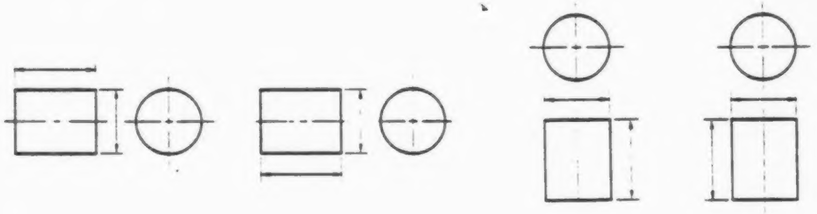
A. Size dimensions

1. Prisms

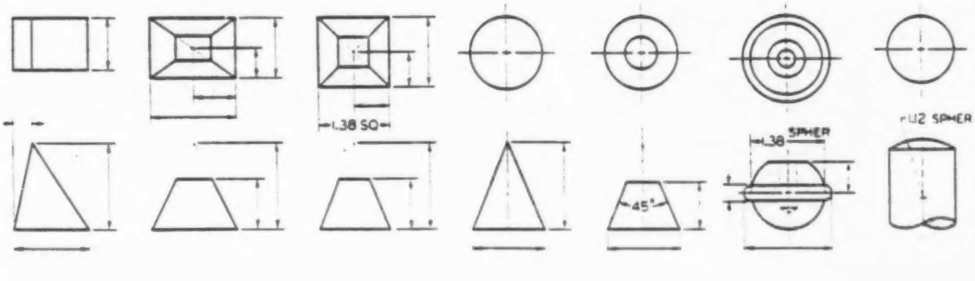


2. Cylinders

NOTE: Diameter is not recommended for circular view, but ANSI does approve its use.

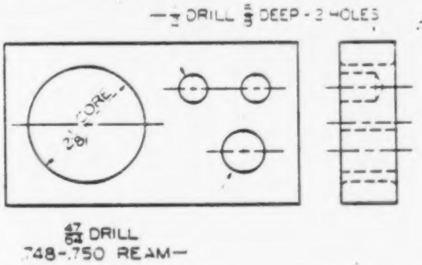


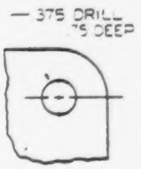
3. Miscellaneous shapes

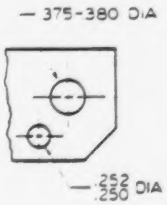


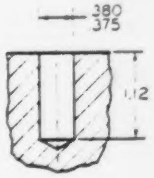
4. Holes (negative cylinders)

NOTE: These may be drilled, reamed, bored, punched, or cored specified by standard notes.



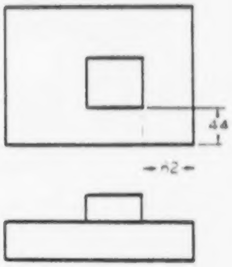






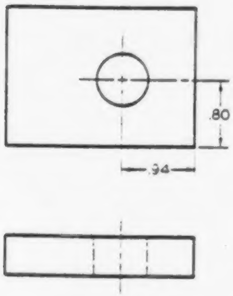
B. Location dimensions

1. Rectangular shapes--references to their faces



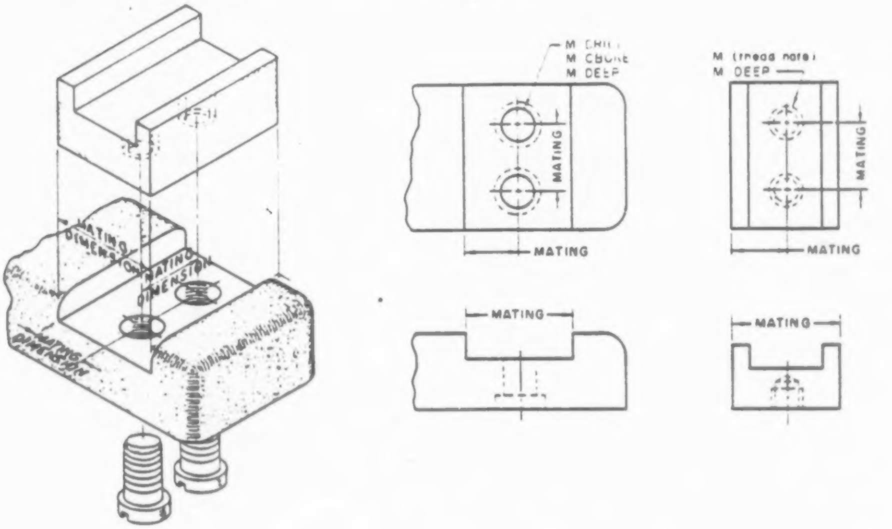
2. Cylinders or holes--reference to their center lines

NOTE: Location dimensions are best located in circular view.



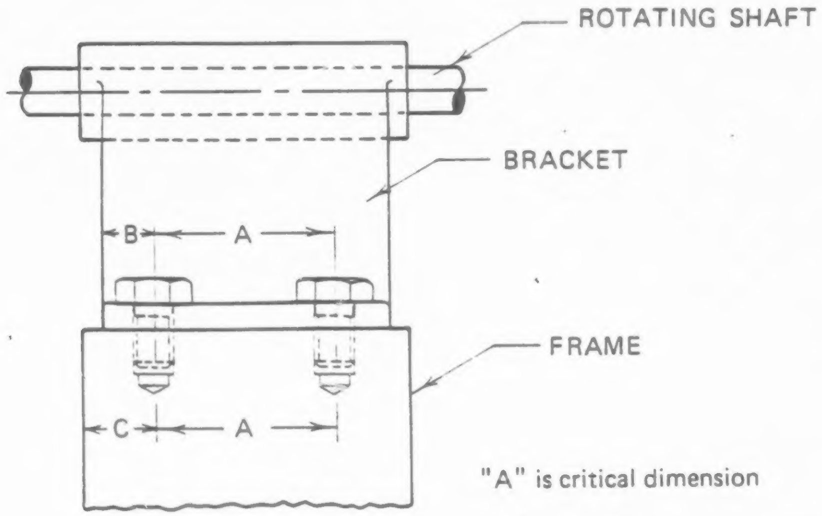
III. Mating dimensions in an assembly drawing

A. Dimensions common to both parts (TM 2.9)



B. Single bracket assembly

NOTE: Critical dimension "A" of frame must mate critical dimension "A" of bracket.

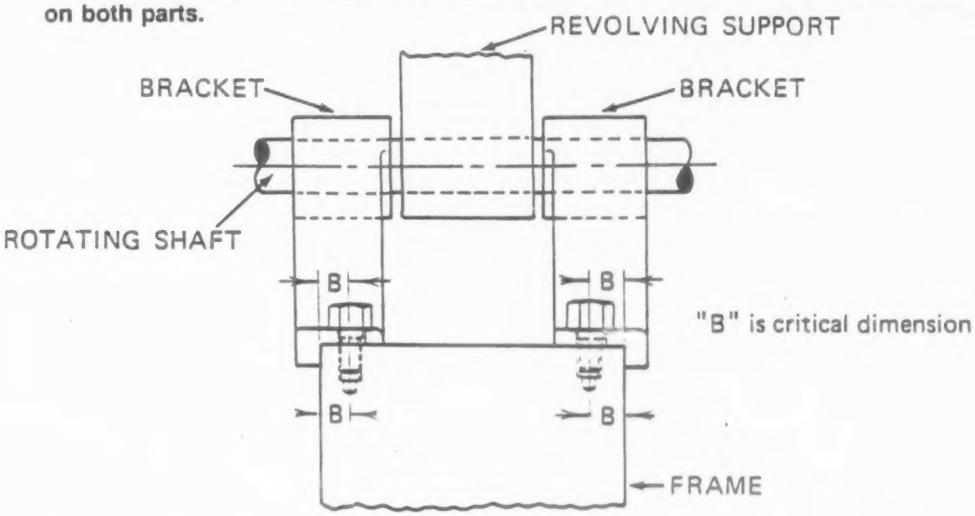


"A" is critical dimension

"B" and "C"
are not critical dimensions

C. Double bracket assembly

NOTE: With double bracket design, dimension "B" is critical dimension that must mate on both parts.



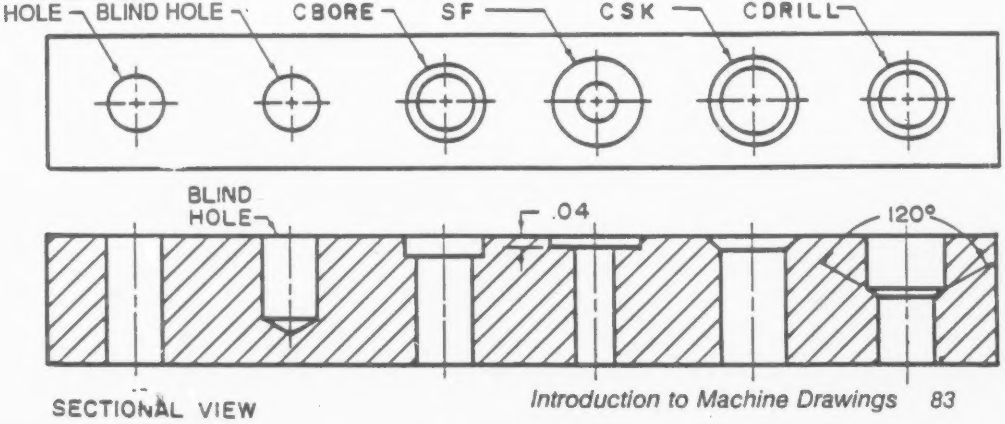
IV. Various standard machine manufactured features

A. Types of holes

1. Through hole
2. Blind hole
3. Counterdrill
4. Counterbore
5. Countersink
6. Spot faced

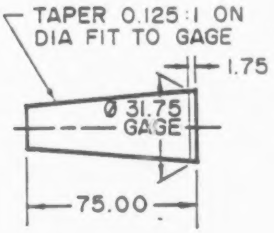
NOTE: Refer to terms and definitions for descriptions. Refer to symbol chart for symbols.

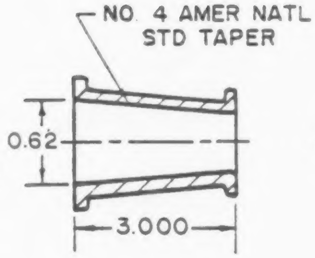
Examples:

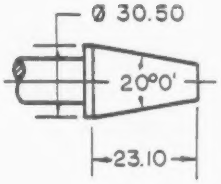


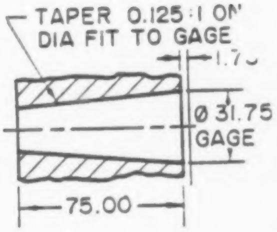
B. Taper

Examples:







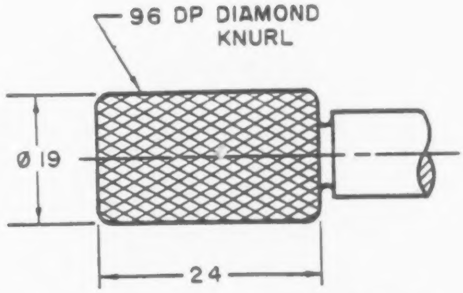


METRIC

C. Knurl

1. Diamond pattern

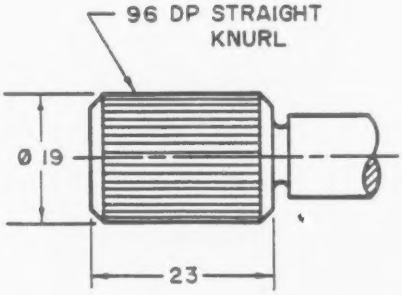
Example:



METRIC

2. Straight line

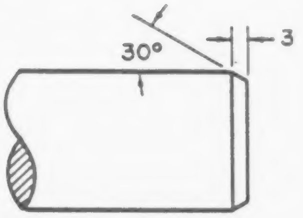
Example:

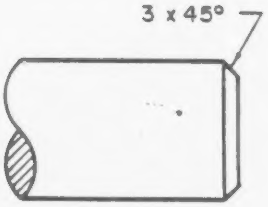


METRIC

D. Chamfers:

Examples:





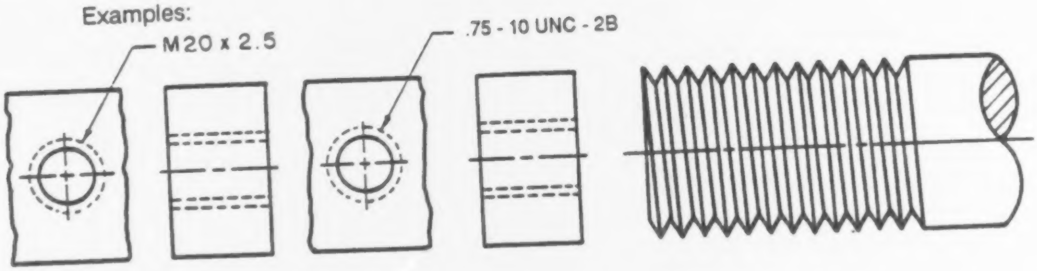
METRIC

E. Threads

1. Internal

2. External

Examples:



F. Keyways and keyseats

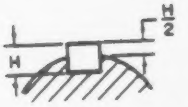
1. Square

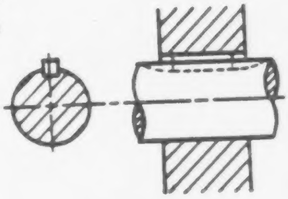
2. Flat

3. Gib head

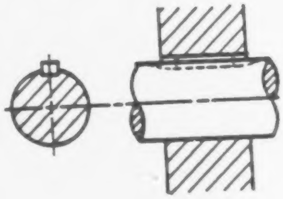
4. Pratt and Whitney

5. Woodruff

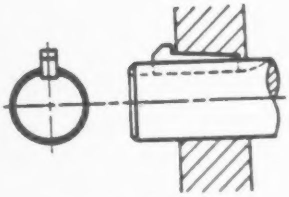




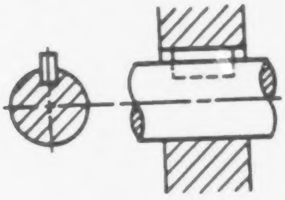
(1) SQUARE KEY



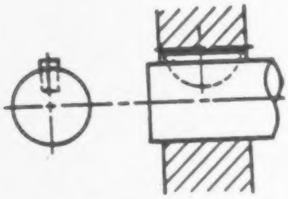
(2) FLAT KEY



(3) GIB HEAD KEY



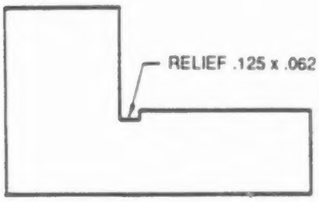
(4) PRATT & WHITNEY KEY



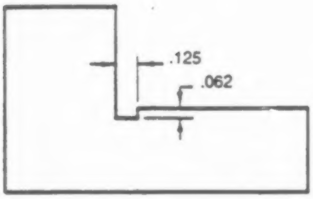
(5) WOODRUFF

G. Relief groove

Examples:



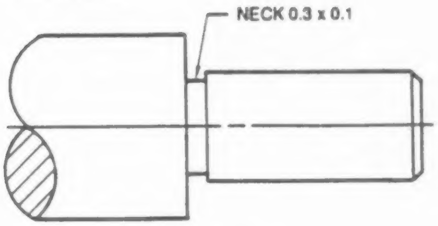
USING A NOTE



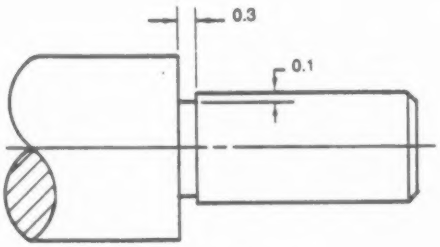
USING DIMENSIONS

H. Neck

Examples:



USING A NOTE



USING DIMENSIONS

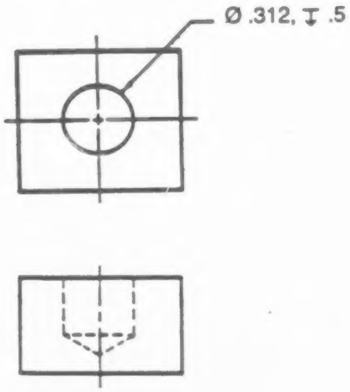
V. Proper dimension notes for standard machine manufactured features

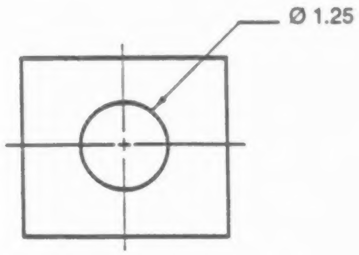
A. Hole operations--holes are always dimensioned on the view in which they appear as a circle (TM 2.10)

1. Drilled, reamed, or bored holes are dimensioned as shown.

NOTE: For drills designated by number or letter, the decimal size must be given.

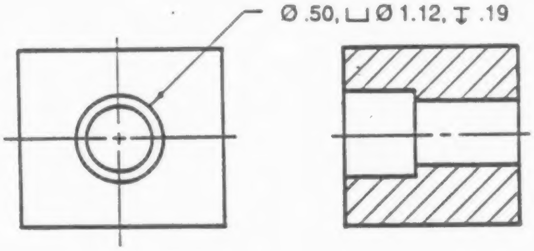
Examples:





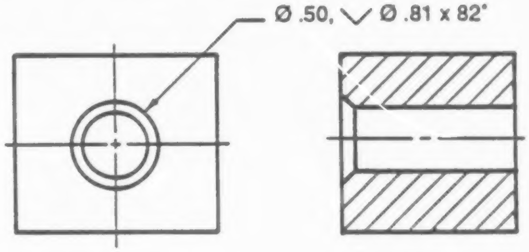
B. Counterbore--diameter of the drill is given first, then the diameter of the bore by the depth it is to be cut.

Example:



C. Countersink--diameter of the drill is given first, then the diameter of the top of countersink by the included angle of the countersink.

Example:

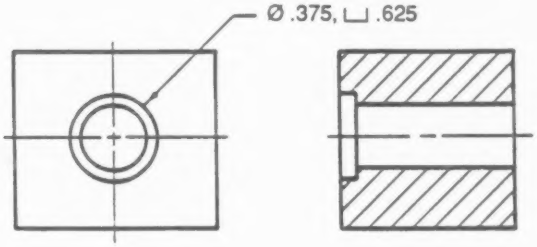


NOTE: The standard countersink for manufacturing is 82°.

D. Spot faced--diameter of the drill is given first, then the diameter is given; the depth is not normally given for a spot face

NOTE: Common practice is for a spot face to be cut 1/16" deep.

Example:

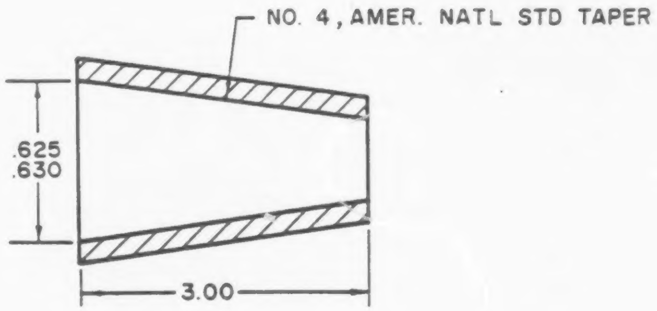


E. Tapers

NOTE: There are three methods of dimensioning a taper; the accuracy required and the machine process available to cut the taper will determine the method to use.

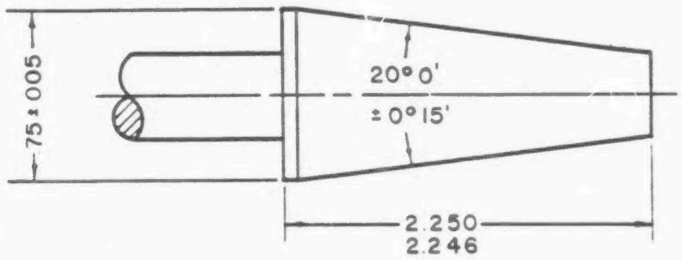
1. Standard machine tapers--the diameter, usually at the large end, and the length are applied to the view in the form of dimensions; the actual taper is given as a note such as "No. 4 AMER. NATL STD TAPER"

Example:



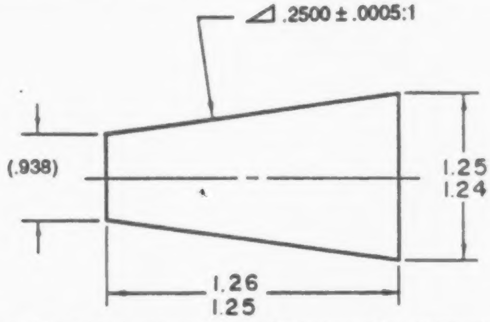
2. Non-critical tapers--the diameter at the large end, the length, and the included angle are applied to the view in the form of dimensions

Example:



3. Critical tapers--the diameter of the large end and the length are applied to the view as dimensions and the "taper per unit on diameter" is indicated on a note.

Example:



NOTE: Taper on diameter means the difference in diameter per unit of length.

F. Knurl

1. Diamond pattern

   a. Coarse knurl (33 pitch)

   NOTE: Pitch is the distance between two points per inch.

   b. Medium knurl (21 pitch)

   c. Fine knurl (14 pitch)

2. Straight pattern

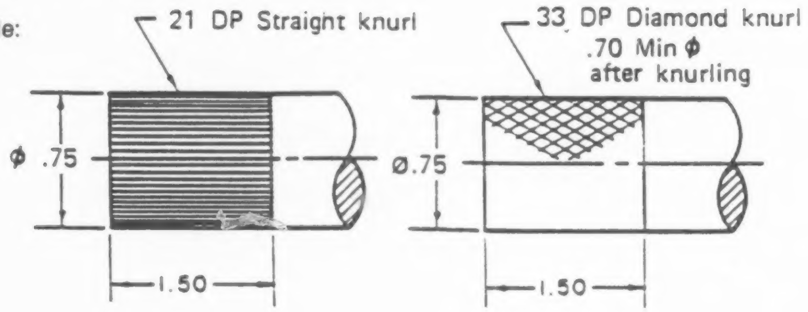
   a. Coarse knurl (33 pitch)

   b. Medium knurl (21 pitch)

   c. Fine knurl (14 pitch)

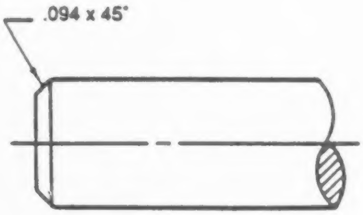
3. The pitch, type of knurl, and the minimum diameter after knurling are applied to the view in the form of a note.

Example:



G. Chamfer--the length of the offset and the angle are applied to the view in the form of a note

Example:



H. Threads

1. Internal thread

   a. Through-drill--the following items are applied to the view in the form of a note

      NOTE: All dimensions should be in decimal.

      1) Nominal thread diameter in decimal

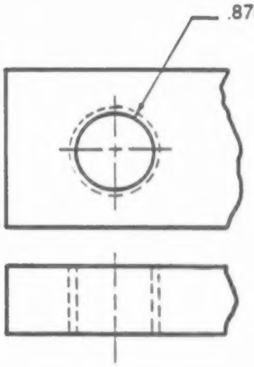
      2) Threads per inch

      3) Thread series type

      4) Class of thread fit

      5) LH (if it is left handed)

Example:



.875 - 14 UNF - 1B

.875 -Nominal thread diameter
14 -Threads per inch
UN -Unified thread series
F -Fine thread series
1 -Class 1 thread fit
B -Internal

NOTE: Tap drill size is determined by referring to American National Standard Thread tables, Machinery Handbook, or various textbook appendixes.

b. Blind drill--the following items are applied to the view in the form of a note

1) Depth of tap drill

2) Nominal thread diameter

3) Threads per inch

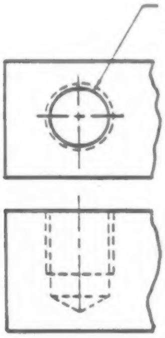
4) Thread series type

5) Class of thread fit

6) LH (If it is left handed)

7) Depth of thread

Example:



.250 - 20 UNC - 2B - LH, ↧ .750

.250 -Nominal thread diameter
20 -Threads per inch
N -National thread form
C -Coarse thread series
2 -Class 2 thread fit
LH -Left hand threads
.750 ↧ -Depth of thread

2. External thread--the following items are added to the view in the form of a note

a. Nominal thread diameter

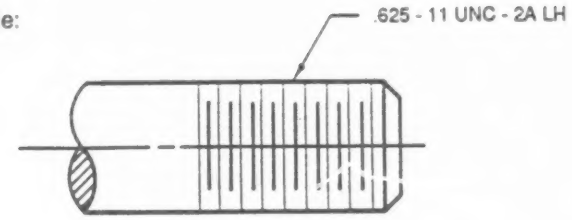
b. Threads per inch

c. Thread series types

d. Class of thread fit

e. LH (if it is left handed)

Example:



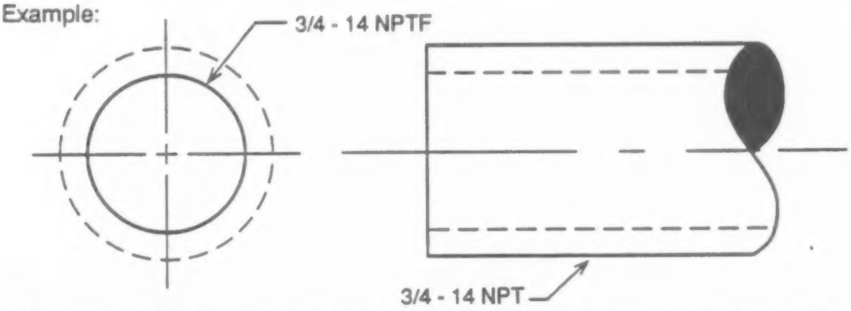
3. Pipe threads

a. Nominal pipe size in decimal or fractional inches

b. Threads per inch

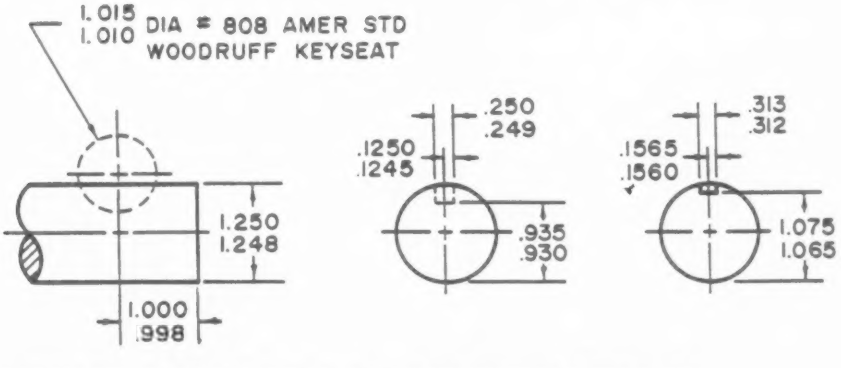
c. Thread type symbol

Example:



l. Keyways--the size and number of the required key are given in the form of a note and the location on the shaft of the keyway is given in the form of dimensions on the two views showing the keyway

Example:

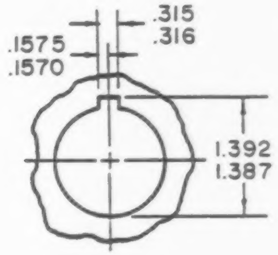


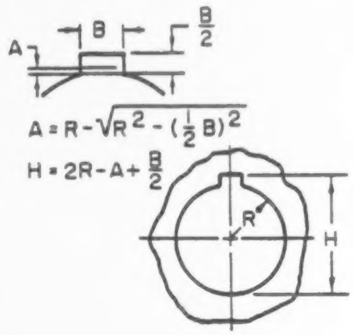
NOTE: Notice the use of a dimension to center the keyway in the shaft.

J. Keyseats--the size and location of the slot are given in the form of dimensions applied to the view

NOTE: The proper clearance for various keys can be obtained from a machine handbook.

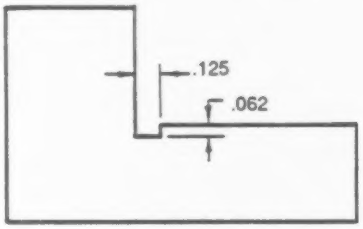
Example:



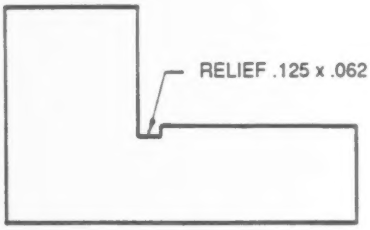

A
B
$\frac{B}{2}$
$A = R - \sqrt{R^2 - (\frac{1}{2}B)^2}$
$H = 2R - A + \frac{B}{2}$
R
H

K. Relief groove--the width and depth of a relief can be given by placing dimensions on the view or in the form of a note

Example:



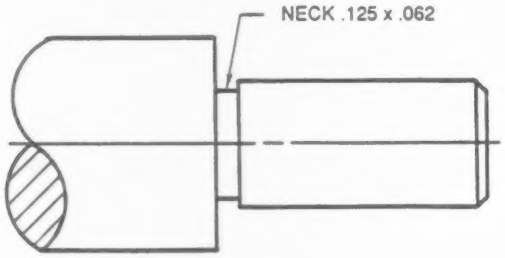
USING DIMENSIONS



USING A NOTE

L. Neck--the width and depth of a neck are given in the form of a note

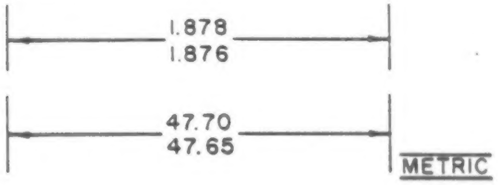
Example:



USING A NOTE

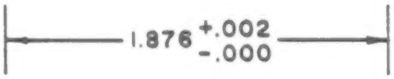
VI. Systems of dimensioning tolerances on drawings (TMs 2.7 and 2.8)

A. Limits

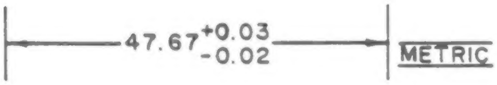


B. Plus and minus

1. Unilateral



2. Bilateral



C. Notes

NOTE: In cases where all tolerances are the same, it is more convenient to list the information in a note than to list the tolerances separately.

Example: Note: Tolerances are ± .010 unless otherwise specified.

VII. Numerical control dimensioning

A. Datum or reference planes must be selected that are mutually perpendicular in the X, Y, and Z axes.

B. Dimensions originate from the three planes.

C. Dimensions must be in decimals.

D. Angles should be in degrees and decimal parts of degrees.

E. Standard tools such as reamers, drills, and tapers should be specified wherever possible.

F. Tolerances should be used based on design requirements rather than tolerances of manufacturing machines.

VIII. Fits for inch units

A. Running and sliding fits

a. RC 1 (Close sliding fits)

b. RC 2 (Sliding fits)

c. RC 3 (Precision running fits)

    d. RC 4 (Close running fits)
    e. RC 5-RC 6 (Medium running fits)
    f. RC 7 (Free running fits)
    g. RC 8-RC 9 (Loose running fits)

  B. Locational fits
    a. LC 1-LC 11 (Locational clearance fits)
    b. LT 1-LT 6 (Locational transition fits)
    c. LN 1-LN 2 (Locational interference fits)

  3. Force fits
    a. FN 1 (Light drive fits)
    b. FN 2 (Medium drive fits)
    c. FN 3 (Heavy drive fits)
    d. FN 4-FN 5 (Force fits)

IX. Calculation of limits in inch units using basic hole system

  A. Calculation of limits for clearance fit

    1. Refer to tolerance fit table for inch units, and locate basic hole size in "nominal size range, inches" column.

    NOTE: Limits are in thousandths of an inch. Multiply limit by .001 for calculations.

    Example: Basic hole size 2.00 fit RC 6 --Go to table--

Nominal size range, inches	Limits of clearance	Standards limits	
		Hole	Shaft
1.97-3.15	2.5 7.3	+3.0 - 0	-2.5 -4.3

    2. Calculate limits for the hole.

    Example: 2.000 + 3.0 (.001) = 2.003 Max. limit (LMC)--largest hole
    2.000 - 0 = 2.000 Min. limit (MMC)--smallest hole

    3. Calculate limits for the shaft.

    Example: 2.000 - 2.5 (.001) = 1.9975 Max. limit (MMC)--largest shaft
    2.000 - 4.3 (.001) = 1.9957 Min. limit (LMC)--smallest shaft

4. Calculate allowance in inch units.

    a. Calculate tightest fit (MMC of hole - MMC of shaft) smallest hole - largest shaft

    Example: 2.000 - 1.9975 = .0025

    b. Look at table under limits of clearance and check your answer against table

    Example: $\frac{.0025}{.001}$ = 2.5 which checks

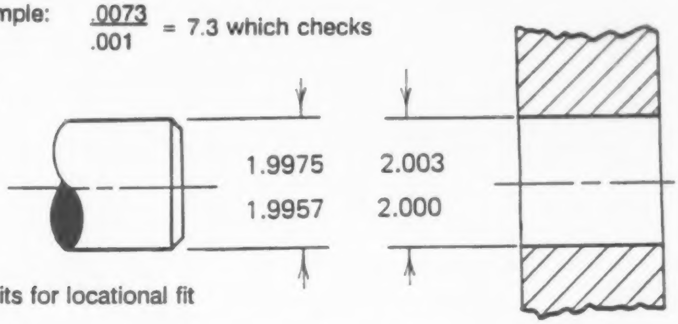
    c. Calculate loosest fit (LMC of hole - LMC of shaft) largest hole - smallest shaft

    Example: 2.0030 - 1.9957 = .0073

    d. Look at table under limits of clearance and check your answer against table

    Example: $\frac{.0073}{.001}$ = 7.3 which checks

5. Dimension



B. Calculation of limits for locational fit

1. Refer to fit table for inch units, and locate basic hole size in "nominal size range, inches" column.

    Example: Basic size 2.00 fit LT 4--Go to table--

2. Calculate limits for the hole.

    Example: 2.00 + 1.8 (.001) = 2.0018 LMC
    2.00 - 0 = 2.0000 MMC

3. Calculate limits for the shaft.

    Example: 2.00 + 1.3 (.001) = 2.0013 MMC
    2.00 + 1 (.001) = 2.001 LMC

4. Calculate fit.

    a. Calculate tightest fit (MMC of hole - MMC of shaft)

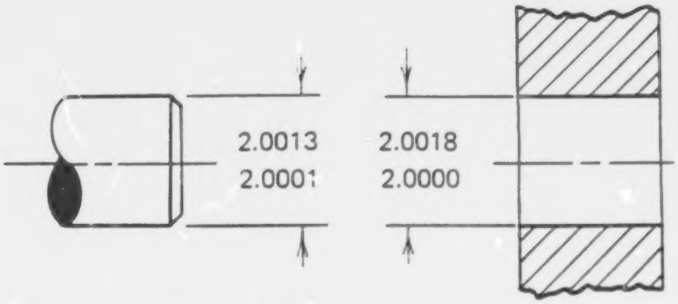
    Example: 2.0000 - 2.0013 = .0013

    b. Calculate loosest fit (LMC of hole--LMC of shaft)

    Example: 2.0018 - 2.0001 = +.0017

    c. Check table under fit to check your answer

5. Dimension



C. Calculation of limits for force fit

1. Refer to fit table for inch units, and locate basic hole size in "nominal size range, inches" column.

   Example: Basic size 2.00 fit FN 3; --Go to table--

2. Calculate limits for the hole.

   Example: 2.00 + (1.2)(.001) = 2.0012 LMC
   2.00 - 0 = 2.0000 MMC

3. Calculate limits for the shaft

   Example: 2.00 + 3.2 (.001) = 2.0032 MMC
   2.00 + 2.5 (.001) = 2.0025 LMC

4. Calculate limits of interference

   a. Calculate tightest interference (MMC of hole - MMC of shaft).

      Example: 2.0000 - 2.0032 = -.0032

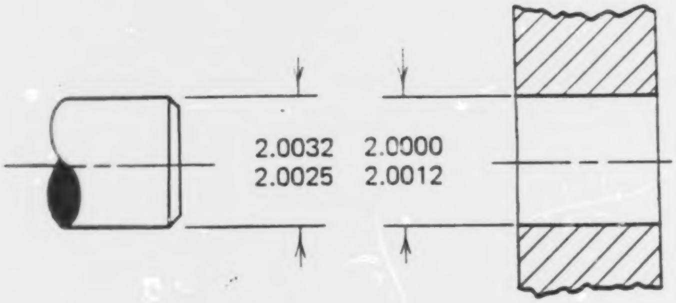
   b. Calculate loosest interference (LMC of hole - LMC of shaft).

      Example: 2.0012 - 2.0025 = -.0013

      NOTE: Notice both have negative values.

   c. Check table under limits of interference to check your answer.

5. Dimension



X. Calculation of limits in inch units using basic shaft system

A. Refer to fit table for inch units, and locate the basic shaft size.

Example: Basic shaft size 2.00 fit RC 6 --Go to table--

Nominal size range, inches	Limits of clearance	Standards limits	
		Hole	Shaft
1.97-3.15	2.5 7.3	+3.0 - 0	-2.5 -4.3

B. Calculate basic hole size by adding allowance at MMC to basic shaft size.

Example: 2.000 + .00025 = 2.0025 basic hole size

NOTE: Now use table as we did in basic hole system.

C. Calculate limits for the hole.

Example: 2.0025 + 3.0 (.001) = 2.0055 LMC
2.0025 - 0 = 2.0025 MMC

D. Calculate limits for the shaft.

Example: 2.0025 - 2.5 (.001) = 2.0000 MMC
2.0025 - 4.3 (.001) = 1.9982 LMC

E. Calculate allowance.

1. Calculate tightest fit (MMC of hole - MMC of shaft)

   Example: 2.0025 - 2.0000 = .0025

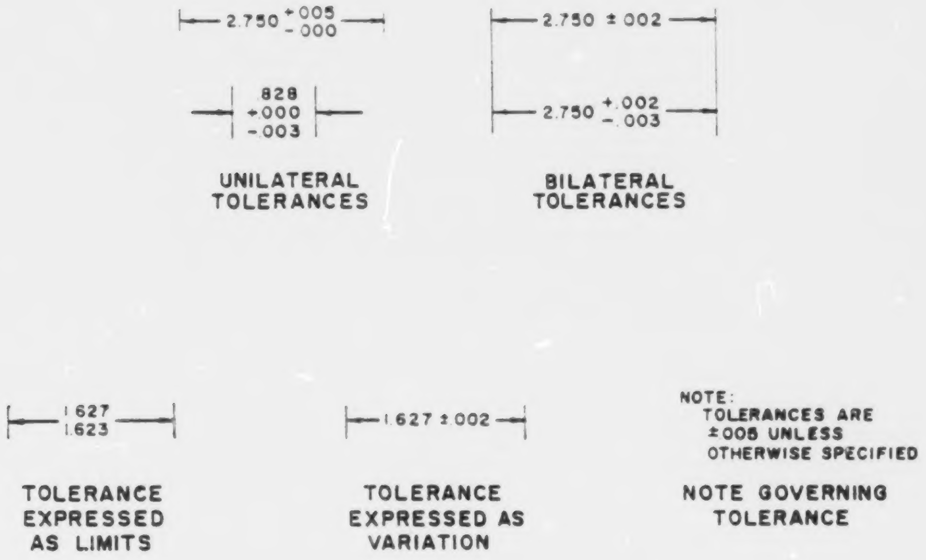
2. Check allowance from table

3. Calculate loosest fit (LMC of hole - LMC of shaft)

   Example: 2.0055 - 1.9982 = .0073

4. Check allowance from table

TYPES OF TOLERANCES



UNILATERAL TOLERANCES

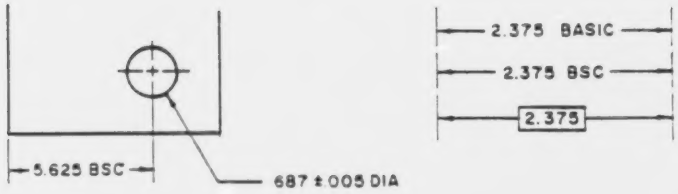
BILATERAL TOLERANCES

TOLERANCE EXPRESSED AS LIMITS

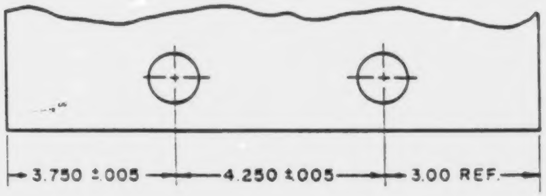
TOLERANCE EXPRESSED AS VARIATION

NOTE GOVERNING TOLERANCE

Indicating tolerances on drawings

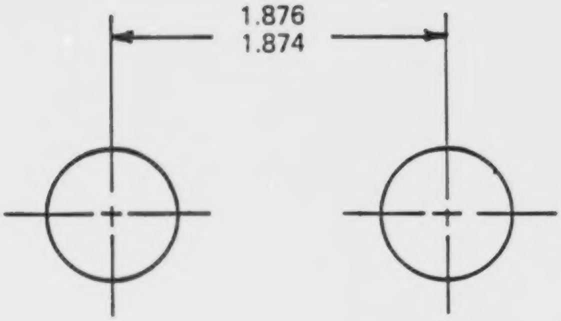


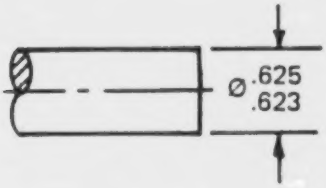
Indicating BASIC dimensions

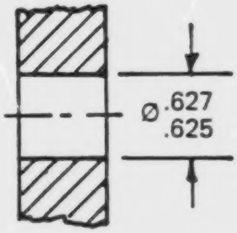


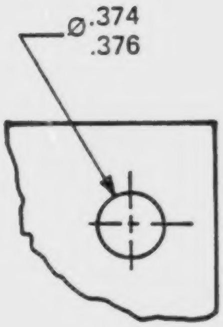
Indicating reference dimensions

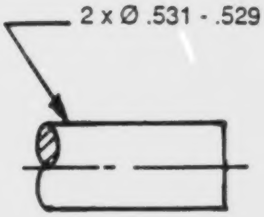
APPLICATION OF DIMENSIONING

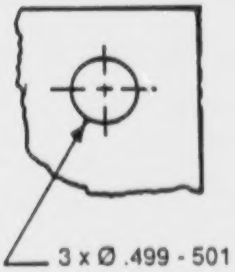


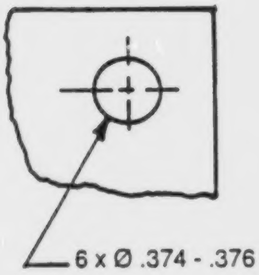




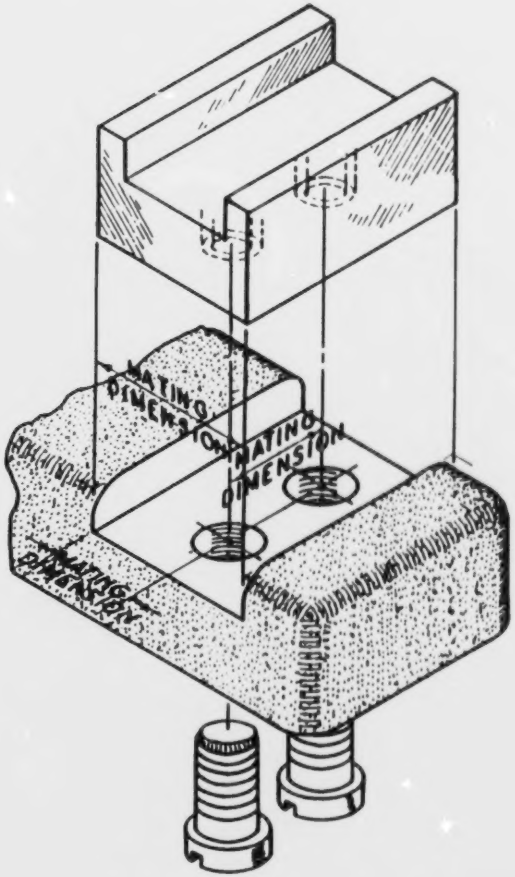


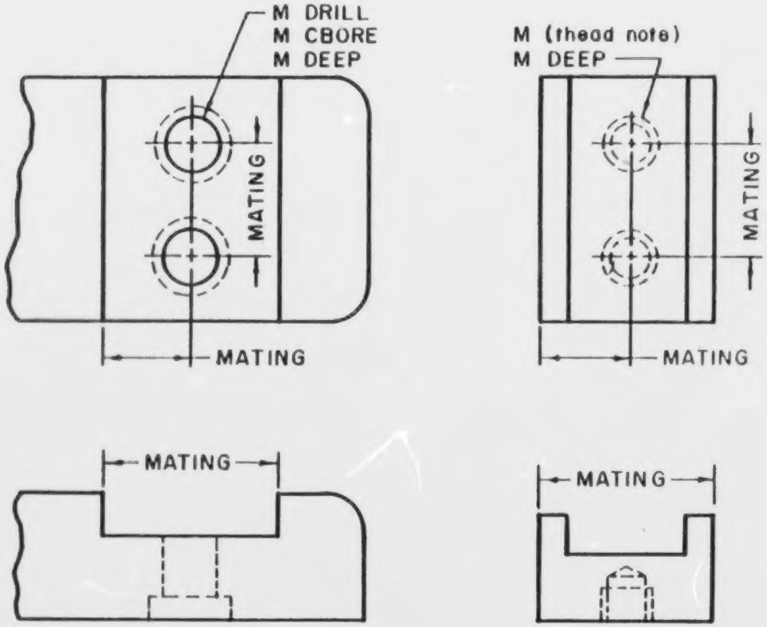




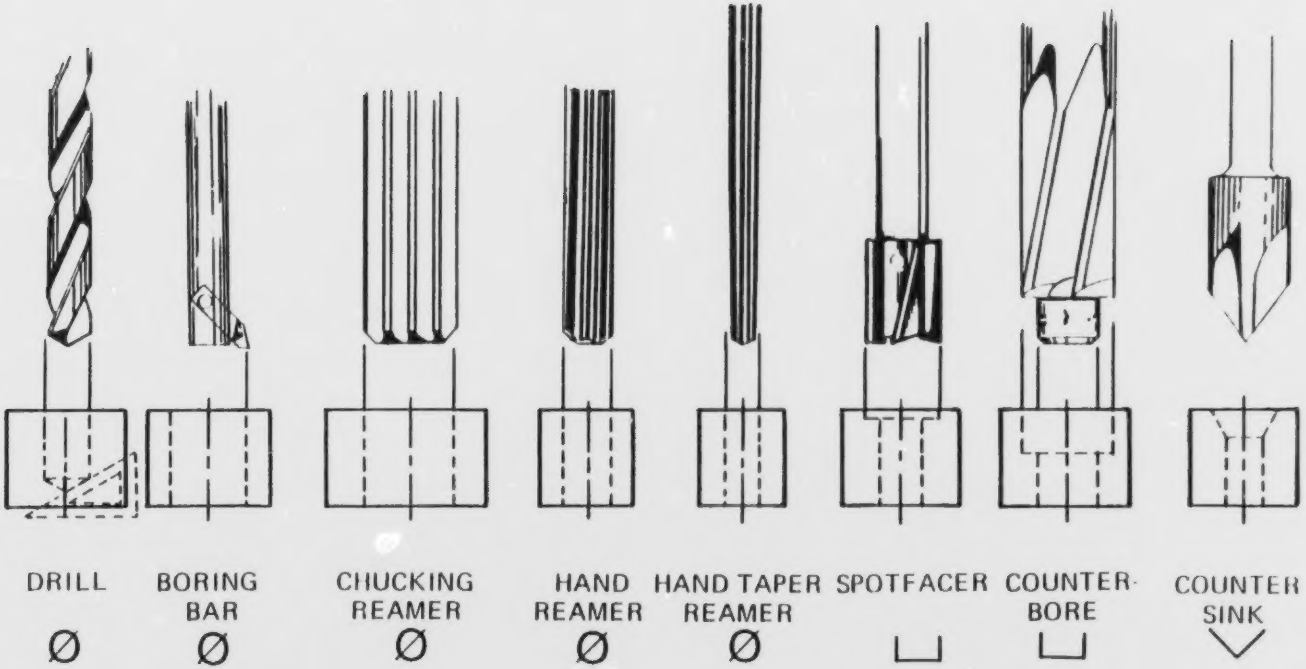


MATING DIMENSIONS





HOLE OPERATIONS



AS 2.6

WRITE PROPER DIMENSION NOTES FOR STANDARD MACHINE MANUFACTURED FEATURES

Premise: Proper dimension notes for standard machine manufactured features can be written by using the procedure in the following example.

Example:

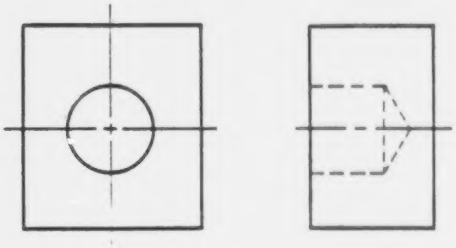
1. Determine what information goes into the note.

   NOTE: This may require using reference tables for features such as tap drill sizes or key sizes.

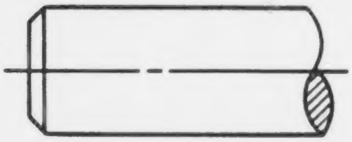
2. Determine in what order machining operations will be performed.
3. Add leader lines to views.
4. Add guidelines for lettering.
5. Letter note.

Directions: Dimension the following standard features correctly by adding all necessary notes and dimensions to the views. Dimension can be taken directly from the views.

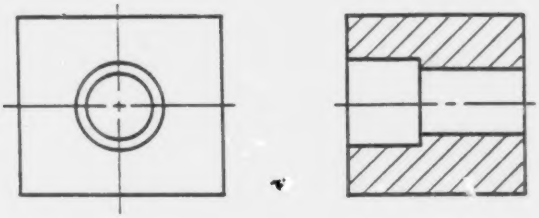
Problem A: Blind drill 25/64 deep



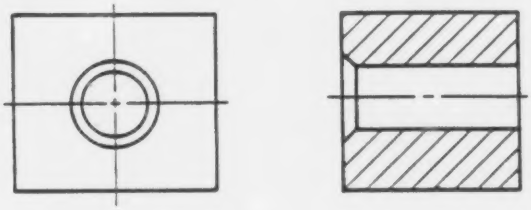
Problem B: Chamfer 3/32



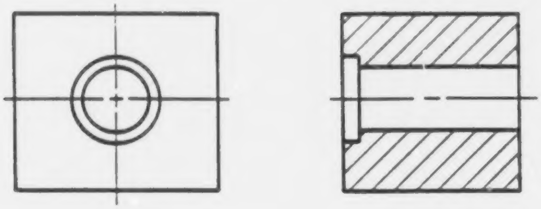
Problem C: Counterbore 12mm, 10mm deep, 9mm drill



Problem D: Countersink 82-degree countersink, 13mm, 9mm drill

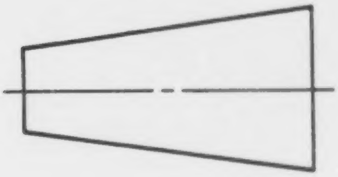


Problem E: Spot faced 1/2" spot faced, 3/8 drill

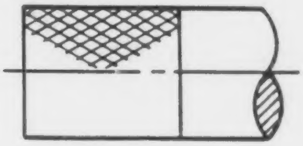


1n.

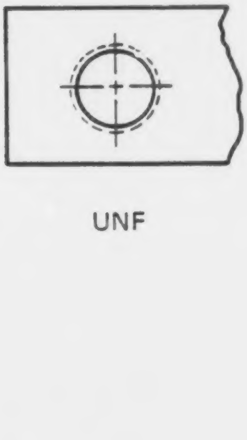
Problem F: Non-critical taper Major diameter .93 ± .006
Length of taper 1.630/1.620
The included angle is 12 degrees ± 30 seconds



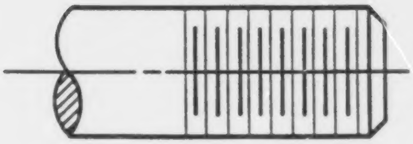
Problem G: Knurl, Diamond with pitch of 33
Minimum diameter .70 after knurling



Problem H: Thread 1/2" internal, 3/4" external



UNF



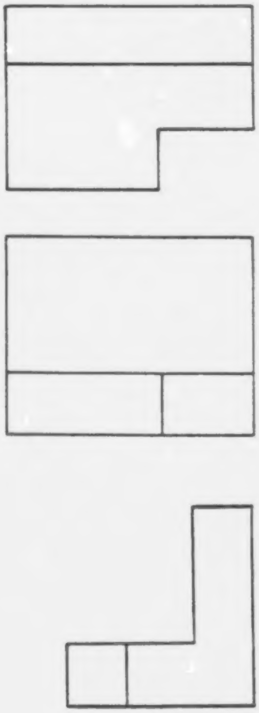
UNC

DIMENSION AN OBJECT COMPLETELY

Directions: With drafting tools and machine, dimension the objects below using proper dimensioning rules and techniques.

Problems:

Full size-inch system-fractions



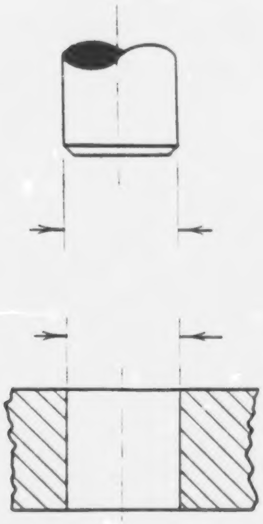
AS 2.8

CALCULATE AND DIMENSION CLEARANCE FIT TOLERANCES USING STANDARD FIT TABLES

Directions: Calculate and dimension the following clearance fit tolerances using standard fit tables.

Problems:

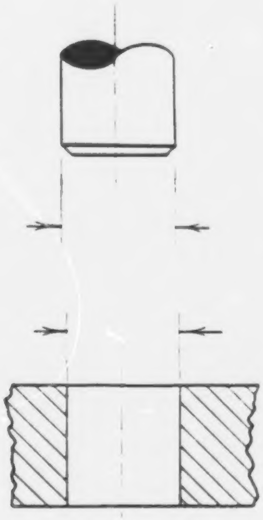
Inch system using ANSI B 4.1 - 1967, R 1974



Fit RC 4

Basic Size 1.00

Check fit



Fit RC 2

Basic Size 2.50

Check fit

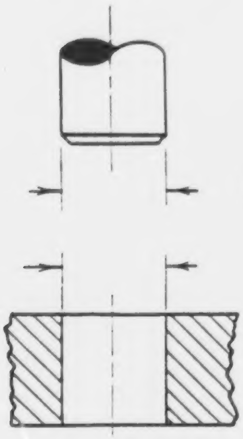
AS 2.9

CALCULATE AND DIMENSION INTERFERENCE FIT TOLERANCES USING STANDARD FIT TABLES

Directions: Calculate and dimension the following interference fit tolerances using standard tables.

Problem:

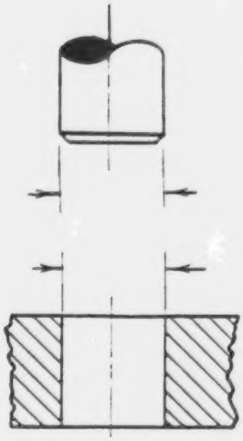
Inch system using ANSI B 4.1 - 1967, R 1974



Fit FN 4

Basic Size 3.00

Check fit



Fit LN 2

Basic Size .5

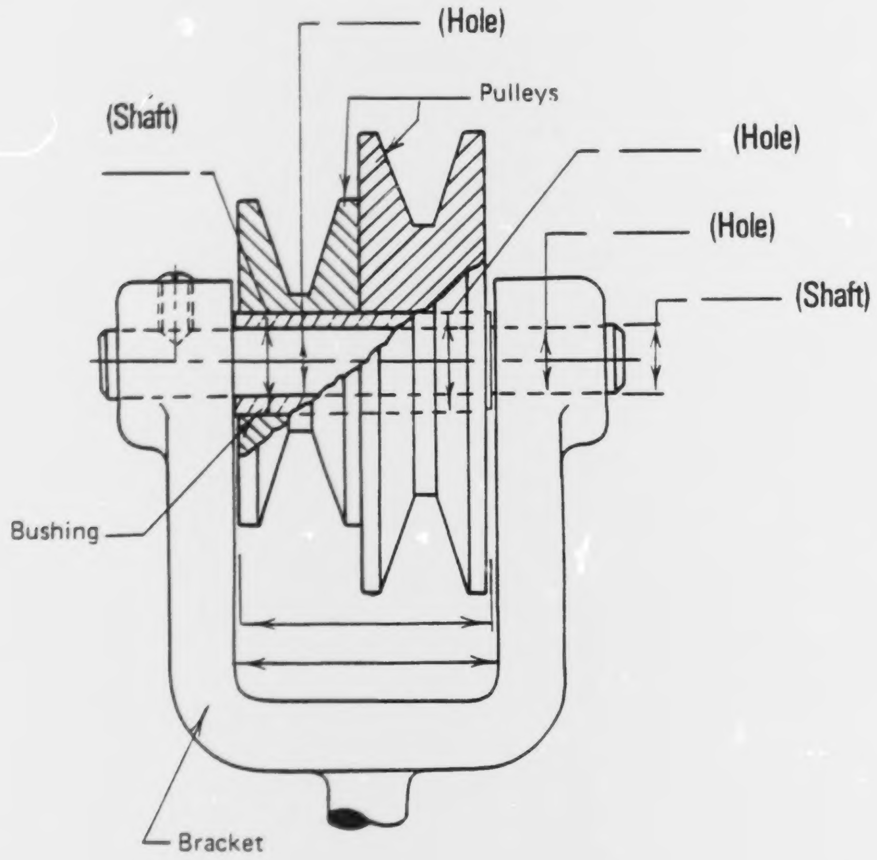
Check fit

CALCULATE AND ASSIGN TOLERANCES TO MATING PARTS USING STANDARD FIT TABLES

Directions: Calculate and assign tolerances to mating parts using standard fit tables for the pulley assembly below.

Problem:

Inch System



Specifications

SHAFT-BRACKET FIT	SHAFT-BUSHING FIT
.75 Nominal diameter	.75 Nominal diameter
Fit RC7	Fit RC 4
BUSHING-PULLEY FIT	BUSHING-BRACKET FIT
1.25 Nominal diameter	3 Nominal length
Fit LN1	Fit RC8

Show calculations below

SHAFT-BRACKET **SHAFT-BUSHING**

BUSHING-PULLEY **BUSHING-BRACKET**

MODULE: INTRODUCTION TO PRODUCTION/MANUFACTURING DRAFTING

UNIT II: INTRODUCTION TO MACHINE DRAWINGS

LESSON 2: DIMENSIONING AND TOLERANCING

ANSWERS TO ASSIGNMENT SHEETS

AS 2.6 -- Evaluated to the satisfaction of the instructor

AS 2.7 -- Evaluated to the satisfaction of the instructor

AS 2.8

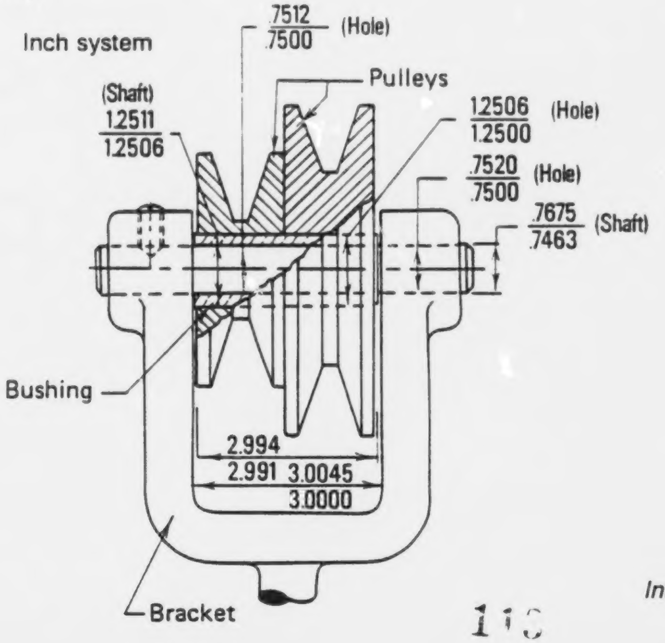
.9992 .9984	2.4996 2.4991
1.0008 1.0000	2.5007 2.5000

AS 2.9

3.0047 3.0040	.5011 .5007
3.0012 3.0000	.5007 .5000

AS 2.10

A. Inch system



MODULE: INTRODUCTION TO PRODUCTION/MANUFACTURING DRAFTING

UNIT II: INTRODUCTION TO MACHINE DRAWINGS

LESSON 3: FASTENERS AND HARDWARE

I. Terms and definitions

A. **Adhesive**--chemical bonding between parts

B. **Detailed threads**--close approximation to actual appearance

C. **External thread**--thread on the outside of a shaft

D. **Fastener**--mechanical device for holding two or more parts in a set position

E. **Finished fastener**--fastener made to close tolerance having a high grade finish

F. **Hardware**--small parts such as fasteners, springs, and washers

G. **High strength fastener**--fastener having high tensile and shear strength

H. **Internal thread**--thread on the inside of a hole

I. **Keys**--used to attach wheels, pulleys, and gears to shafts

J. **Lead**--distance a screw travels in one rotation

K. **Left-hand thread**--advances when turned counterclockwise

L. **Multiple threads**--thread having multiple starts, and the lead is equal to a multiple of the pitch

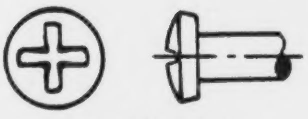
Example: Double thread has a lead of twice the pitch

M. **Nuts**--designed for fastening, adjusting, and transmitting motion or power

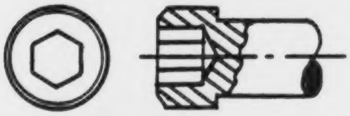
N. **O-Rings**--used to seal along a shaft

O. **Pins**--designed for semi-permanent attachment or location

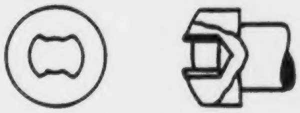
P. **Recessed head**--head having a specially formed indentation centered in its top



Cross (Phillips)



Socket



Clutch

Q. **Retaining ring**--has a removable shoulder to accurately retain, locate, or lock components in bases and housings or on shafts

NOTE: This is also called a snap ring.

R. **Right-hand thread**--advances when turned clockwise

S. **Schematic threads**--more detailed than simplified but faster to draw than detailed threads

T. **Screw thread form**--profile of the thread

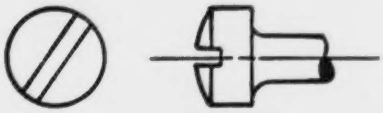
U. **Semi-finished fastener**--fastener made with greater tolerances than a finished fastener and having only the bearing surface and threads finished

V. **Series of thread**--number of threads per inch based on standard nominal diameters

W. **Simplified threads**--least amount of drawing information necessary to convey information without confusion

X. **Single thread**--thread having one start, and the lead is equal to the pitch

Y. **Slotted head**--head having a slot centered across the top



Z. **Springs**--used for storage of mechanical energy

AA. **Unfinished fastener**--fastener with wide tolerances and all surfaces in their formed conditions

BB. **Washers**--designed to insulate, lubricate, span large holes, and distribute stress over a larger area

CC. **Welding**--joining parts by melting base metal to form a unit structure to support loads

II. General types of fasteners

A. Removable

Example: Bolts, keys, screws

B. Permanent

Example: Rivets, welds, adhesives

III. Basic applications of screw threads

A. Holding parts together

B. Adjustment

C. Power transmission

IV. Screw thread nomenclature (TM 2.11)

A. Crest

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B. Root

C. Side

D. Major diameter

E. Pitch diameter

F. Minor diameter

G. Depth

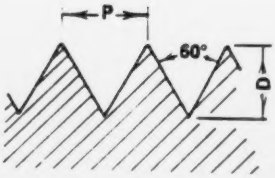
H. Axis

I. Thread angle

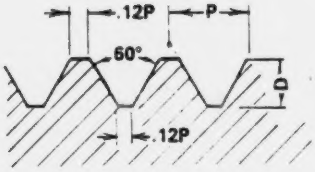
J. Pitch

V. Screw thread profiles (TM 2.12)

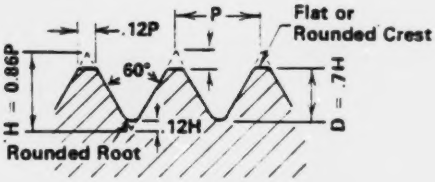
A. Sharp V--adjustments



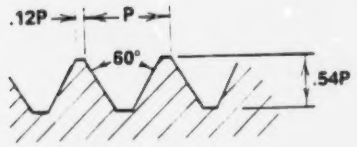
B. American National--General Purpose



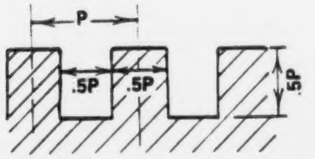
C. Unified



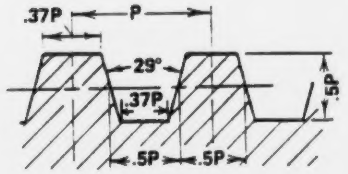
D. Metric



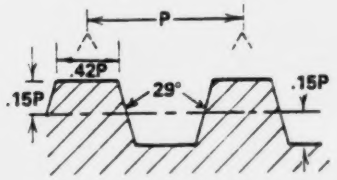
E. Square



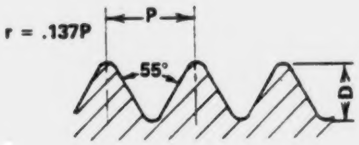
F. Acme--General Purpose



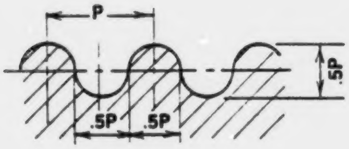
G. Acme--Stub



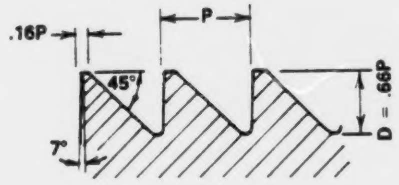
H. Whitworth Standard



I. Knuckle



J. Buttress



VI. Computing lead of thread

A. Single thread lead = Pitch

B. Double thread lead = (2) (Pitch)

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C. Triple thread lead = (3) (Pitch)

D. Multi-threads lead = (Number of threads) (Pitch)

NOTE: Pitch = $\frac{1}{\text{Number of threads per inch}}$

Example: 12 threads per inch

Pitch = 1/12

Lead = 1/12 for single thread

Lead = 2/12 or 1/6 for double thread

VII. Screw thread symbols (TMs 2.13 and 2.14)

A. Simplified

B. Schematic

C. Detailed

D. Combined

VIII. Classes of fit for unified threads and uses

A. Classes 1A and 1B--for parts that are easy to assemble; ordinance and other special uses; quick assembly

B. Classes 2A and 2B--for general purposes and most common uses

C. Classes 3A and 3B--for close tolerance screw thread

NOTE: "A" refers to internal and "B" refers to external.

IX. Parts of thread notes

A. American National Screw Threads (TMs 2.15 and 2.16)

1. Major diameter
2. Threads per inch
3. Profile
4. Series
5. Class of fit
6. Left hand
7. Thread depth

B. American National Standard Unified (TM 2.17)

1. Major diameter
2. Threads per inch
3. Series
4. Class of fit
5. Internal or external thread
6. Left hand

X. Conventional representations of threads

A. Schematic

B. Simplified

XI. Types of threaded removable fasteners (TM 2.18)

A. Bolts

B. Studs

C. Cap screws

D. Machine screws

E. Set screws

XII. Shapes of bolts and nuts

A. Square head

B. Hexagon head

NOTE: Bolt specifications would include nominal size, thread type, length of bolt, finish of bolts, style of head, and name.

XIII. Types of locknuts and locking devices (TM 2.19)

A. Jam nuts

B. Lock washer

C. Cotter pin

D. Set screw

E. Hex slotted nut

F. Hex castle nut

G. Stop nut

H. Elastic stop nut

I. Spring head

J. Wire rap nuts

K. Serrated face nut

L. Captive washer

XIV. Types of standard cap screws (TM 2.20)

A. Hexagon head

B. Flat head

C. Round head

D. Fillister head

E. Hex socket head

XV. Types of machine screws (TM 2.21)

A. Round head

B. Flat head

C. Oval head

D. Fillister head

XVI. Set screw heads and points (TM 2.22)

A. Heads

1. Slotted

2. Hex socket

3. Fluted socket

4. Square

B. Points

1. Cup

2. Flat

3. Oval

    4. Full dog
    5. Half dog
    6. Cone

XVII. Miscellaneous bolts and screws (TMs 2.23 and 2.24)

  A. Stove bolt
  B. Collar bolt
  C. Hanger bolt
  D. Step bolt
  E. Track bolt
  F. Square neck bolt
  G. Fin neck bolt
  H. Countersunk-square neck bolt
  I. Ribbed neck bolt
  J. Countersunk bolt
  K. Roundhead bolt
  L. Turnbuckle
  M. Clevis
  N. Thumb screw
  O. Wing nut
  P. T-head bolt
  Q. Plow bolt
  R. Eye bolt
  S. U-bolt
  T. Hook bolt
  U. Askew-head bolt
  V. J-bolt
  W. Lag screw

- X. Square head bolt
- Y. Hexagon head bolt
- Z. Aircraft bolt
- AA. Lab bolt
- BB. Tapping screw
- CC. Tamper proof fasteners
  - 1. Spanner
  - 2. One way

XVIII. Devices to lock components on a shaft (TM 2.25)

- A. Sunk key (Pratt & Whitney)
- B. Woodruff key
- C. Square key
- D. Flat plain parallel key
- E. Square type taper key
- F. Flat type taper key
- G. Square gib head key
- H. Flat gib head key
- I. Taper pins
- J. Cotter key
- K. Retaining rings-internal
- L. Retaining rings-external
- M. Self-locking rings

XIX. Types of keys to prevent relative motion between wheel and shaft (TM 2.26)

- A. Square
- B. Flat
- C. Gib head
- D. Pratt and Whitney

    - E. Woodruff
    - F. Round

      NOTE: Keys are ordered by size except Woodruff keys which are ordered by number.

- XX. Washers (TM 2.27)
    - A. Flat washers--bearing surface

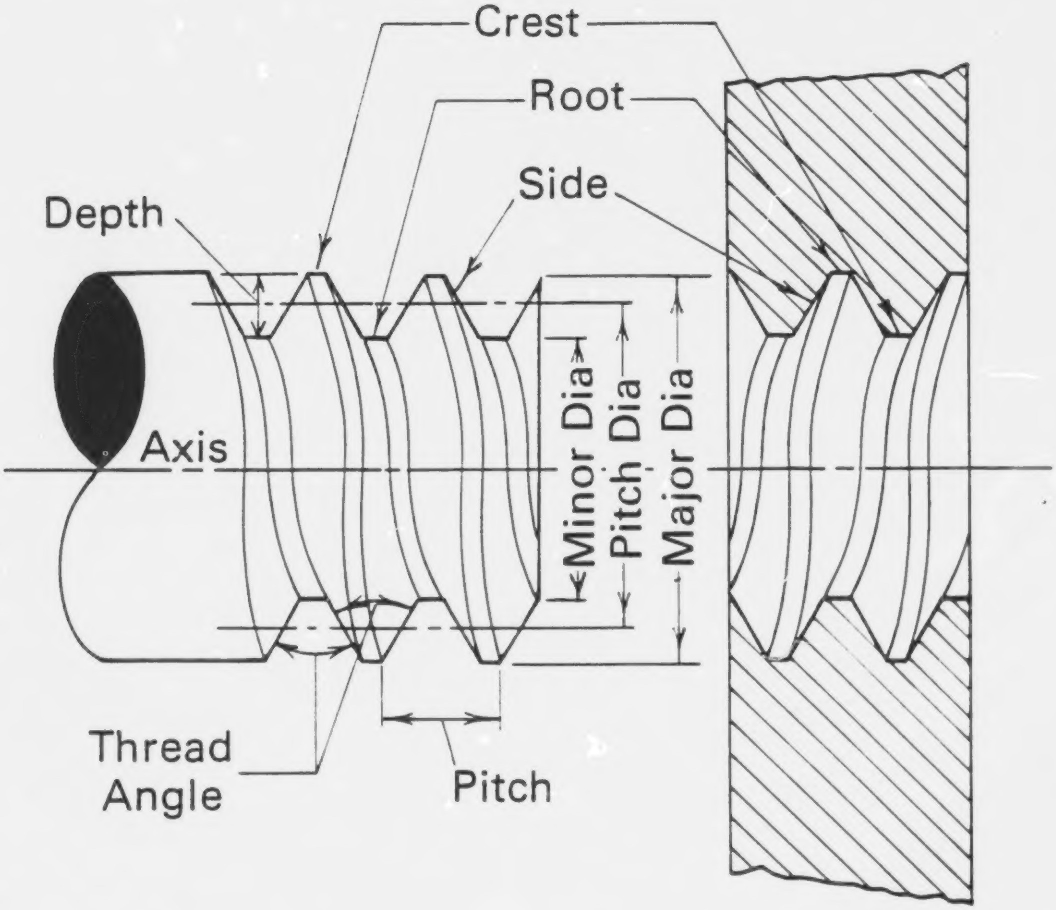
      NOTE: The two types include heavy and standard.

    - B. Conical washers--spring action
    - C. Helical spring washers--locking
    - D. Tooth lock washers--locking
    - E. Spring washers--built-in pressure
    - F. Special purpose washers--decoration and other functions

      NOTE: These are available in plated and unplated finishes.

- XXI. Types of lock washers (TM 2.28)
    - A. Helical spring
        - 1. Plain
        - 2. Nonlink positive
    - B. Tooth lock
        - 1. Internal
        - 2. External
        - 3. Countersunk
        - 4. External-internal
        - 5. Dome
        - 6. Dished
        - 7. Pyramidal

SCREW THREAD NOMENCLATURE

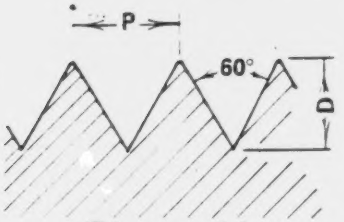


External Thread

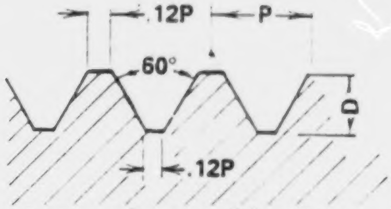
Internal Thread

$$\text{Pitch} = \frac{1}{\text{Number of Threads Per Inch}}$$

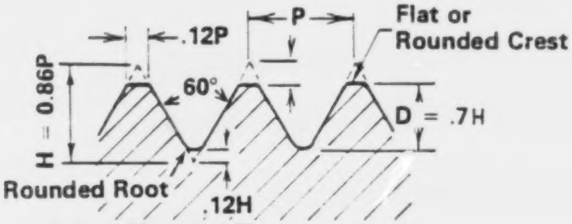
SCREW THREAD PROFILES



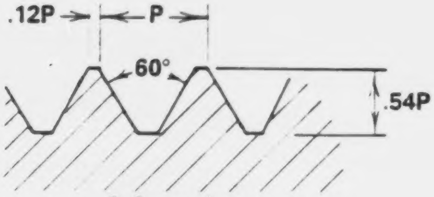
Sharp V



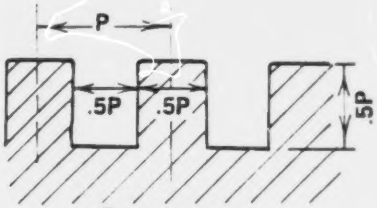
American National



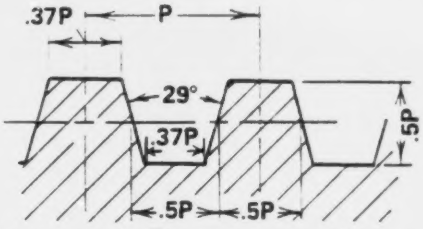
Unified (External)



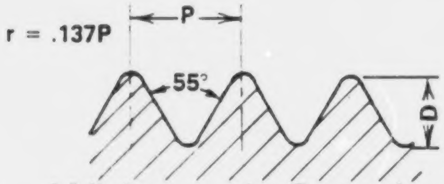
Metric



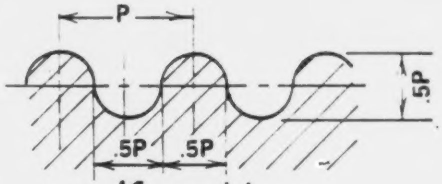
Square



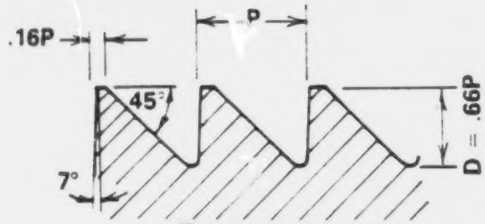
General Purpose Acme



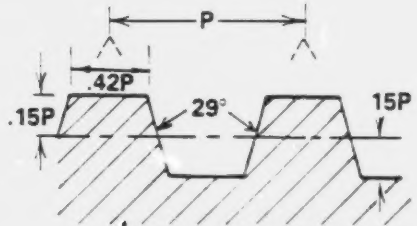
Whitworth Standard



Knuckle



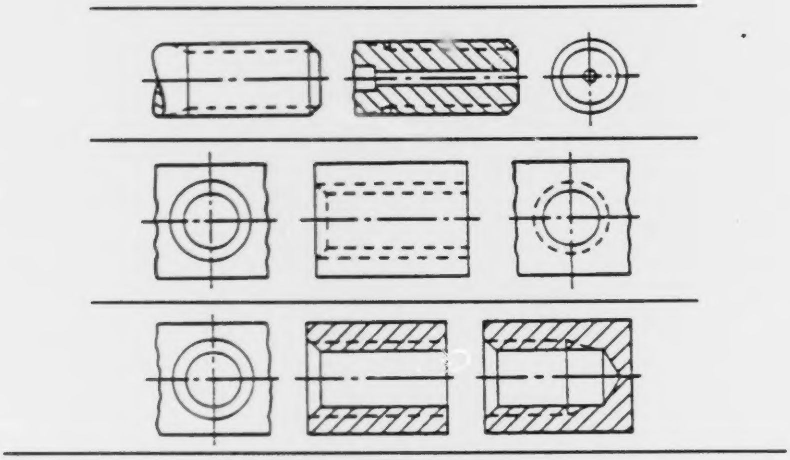
Buttress



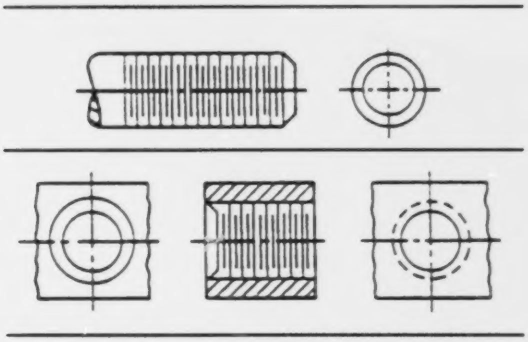
Acme--Stub

(NOTE: Dimensions may be used to approximate the threads for detail drawings.)

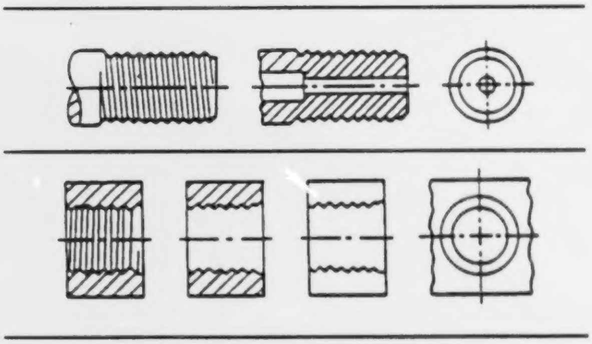
SCREW THREAD SYMBOLS



SIMPLIFIED REPRESENTATION OF THREADS

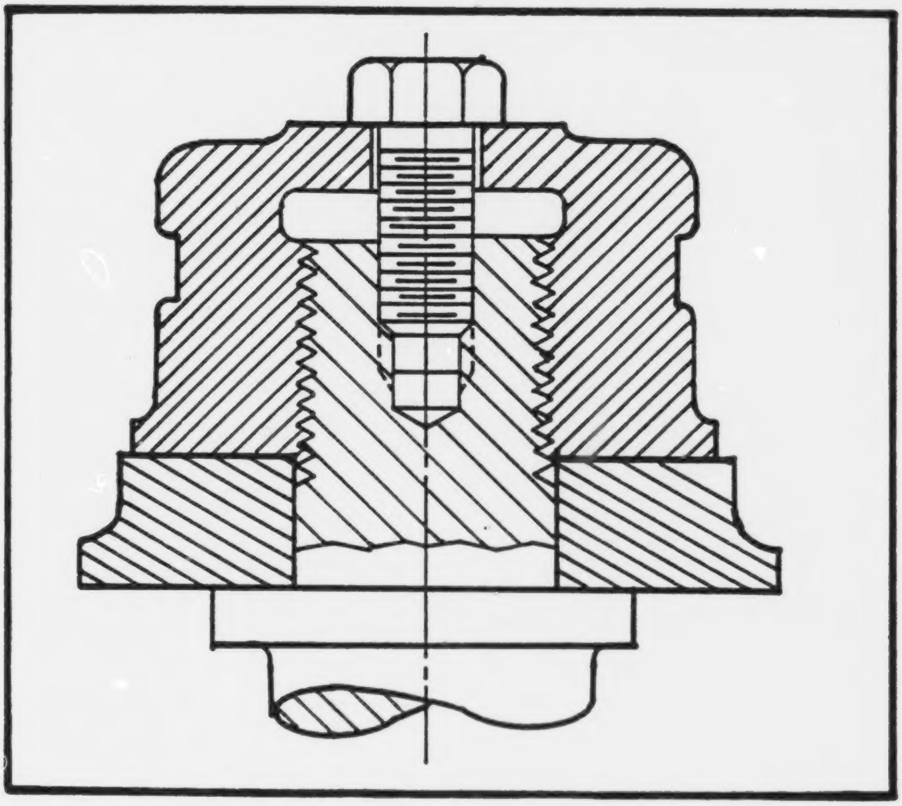


SCHEMATIC REPRESENTATION OF THREADS



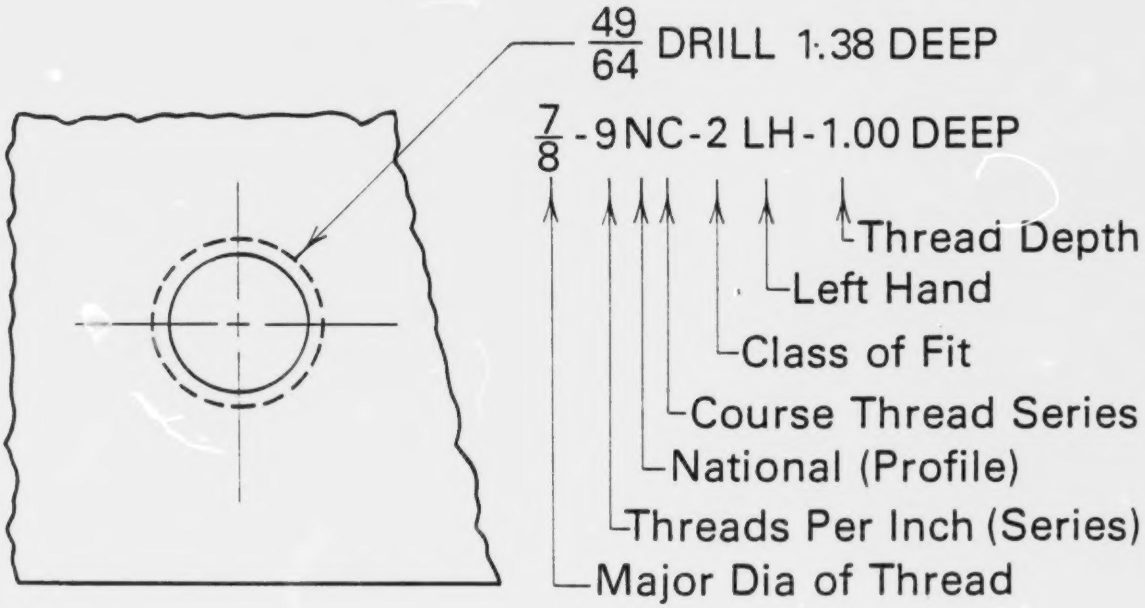
DETAILED REPRESENTATION OF THREADS

COMBINED SCREW THREAD SYMBOLS



Courtesy of Hulen & Hulen, Columbia, MO

AMERICAN NATIONAL THREAD NOTE FOR HOLES



$\frac{49}{64}$ DRILL 1.38 DEEP

$\frac{7}{8}$ - 9 NC - 2 LH - 1.00 DEEP

Thread Depth

Left Hand

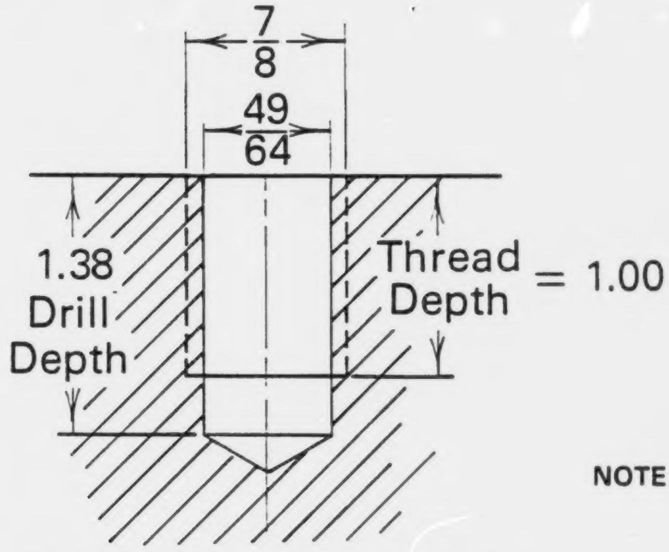
Class of Fit

Course Thread Series

National (Profile)

Threads Per Inch (Series)

Major Dia of Thread

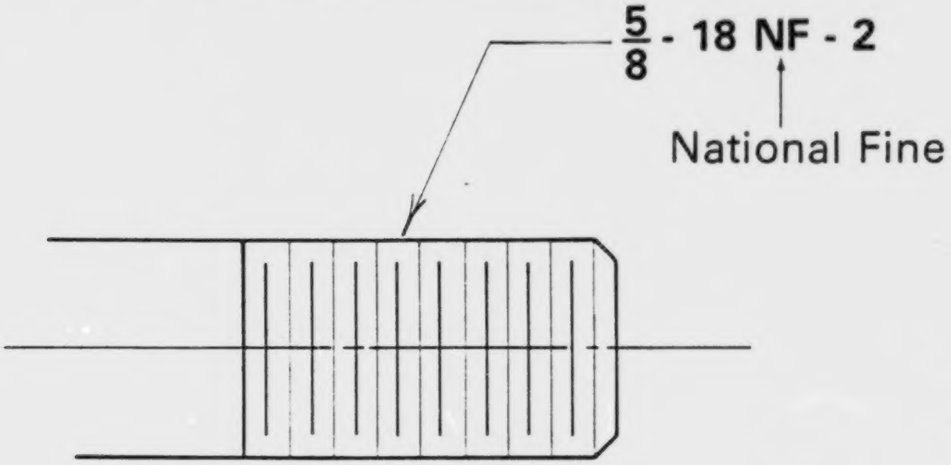


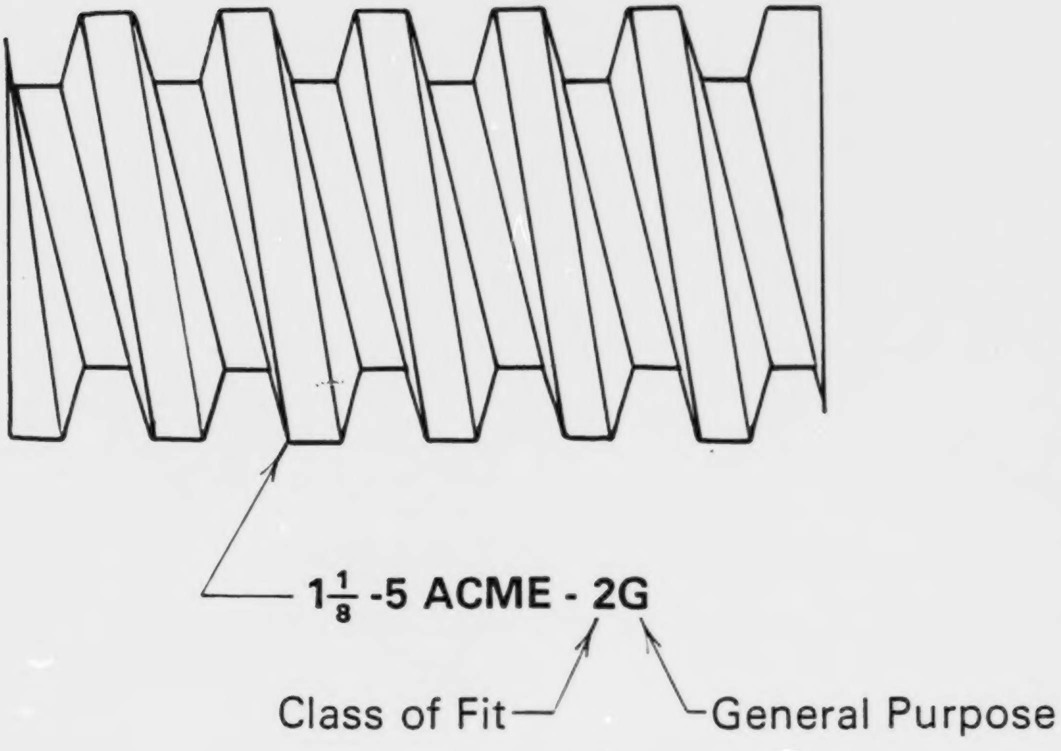
Interpretation of Note

NOTE: **Obtain tap drill size from thread chart.**

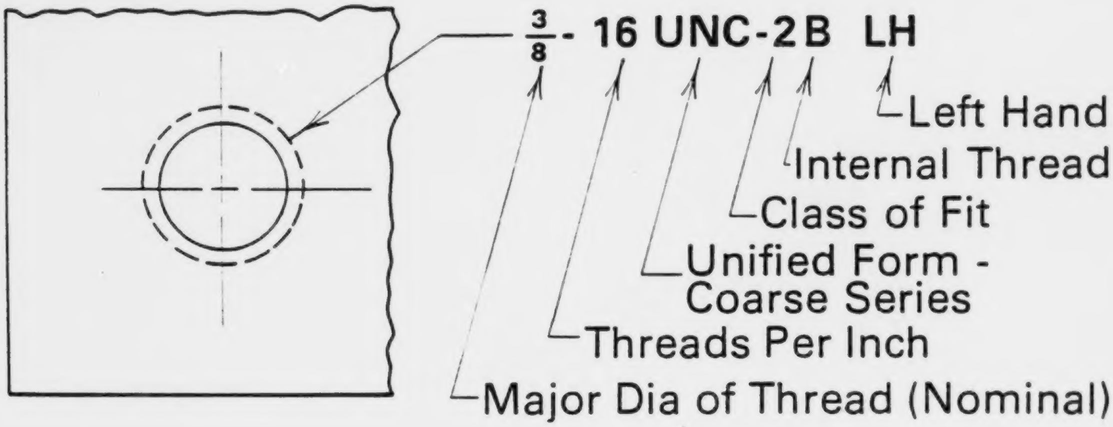
AMERICAN NATIONAL THREAD NOTES

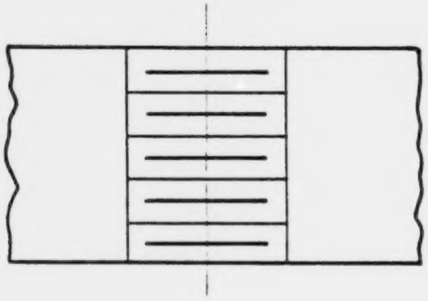
FOR THREADED SHAFT

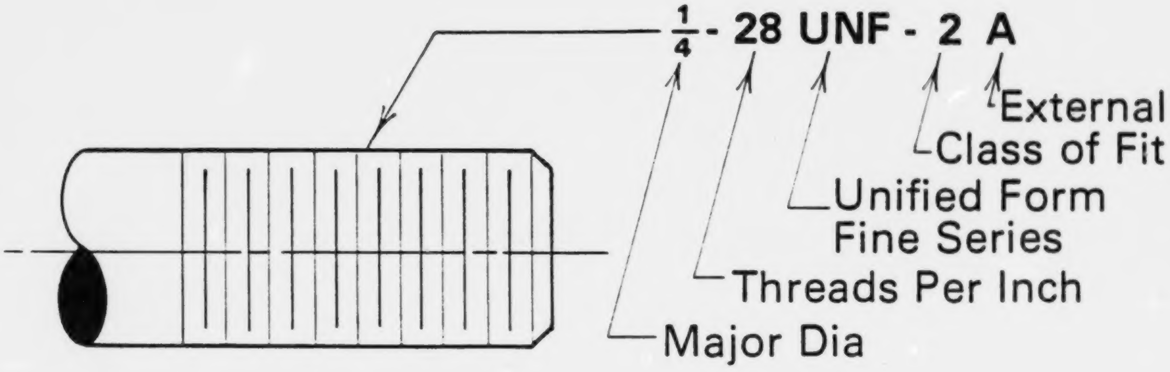




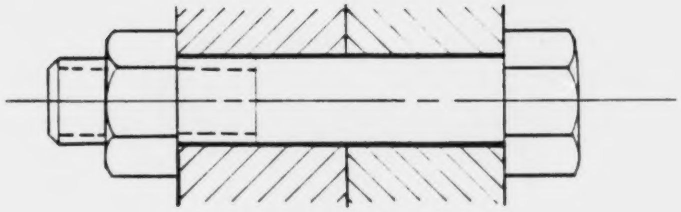
AMERICAN STANDARD UNIFIED THREAD NOTES



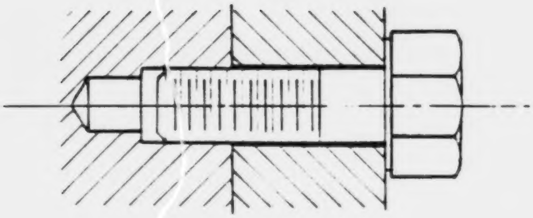




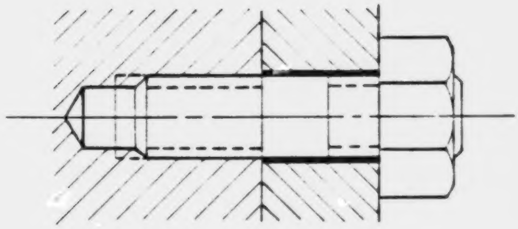
REMOVABLE FASTENERS



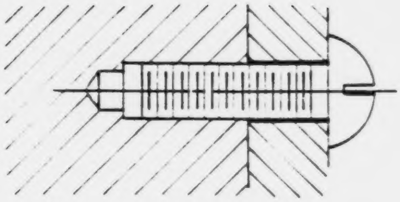
Bolt



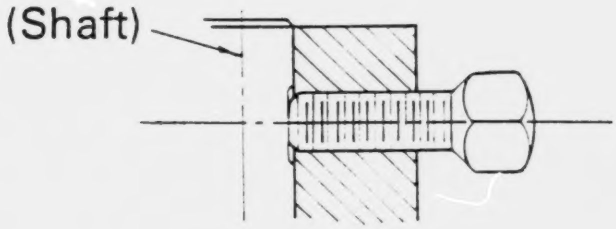
Cap Screw



Stud

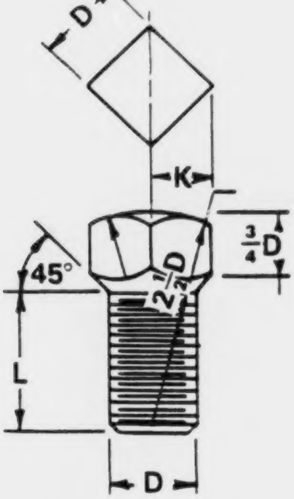


Machine Screw

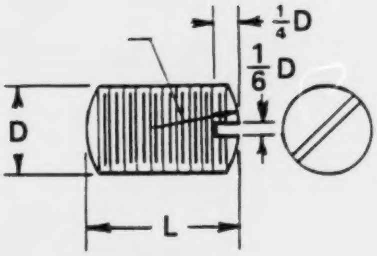


Set Screw

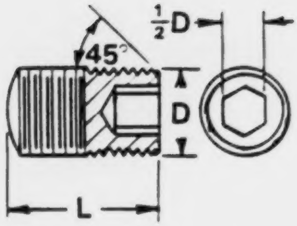
SET SCREWS



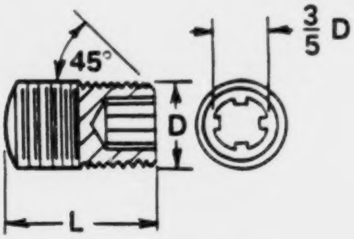
Square Head



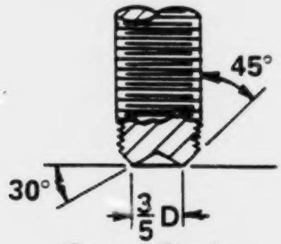
Slotted



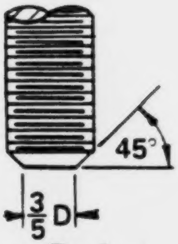
Hex Socket



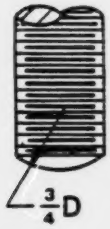
Socket Spline



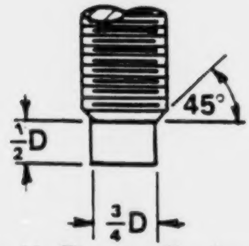
Cup Point



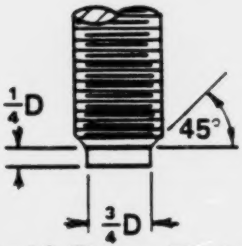
Flat Point



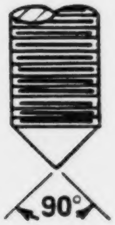
Oval Point



Full Dog Point



Half Dog Point

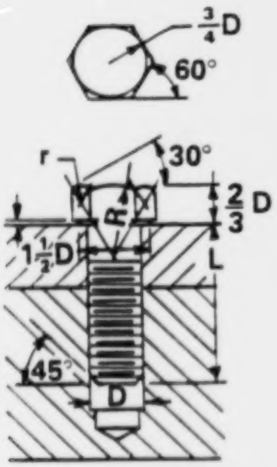


Cone Point

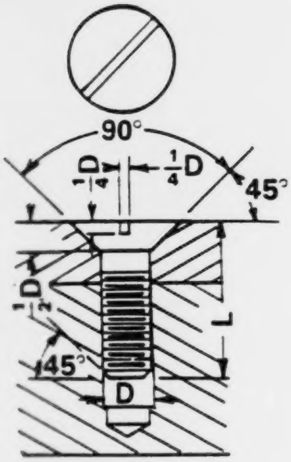
D = Thread Diameter
L = Length

(NOTE: These are approximate dimensions for drawing purposes. Use hardware or standards catalogs for accurate dimensions.)

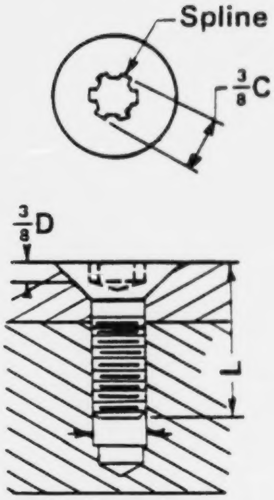
STANDARD CAP SCREWS



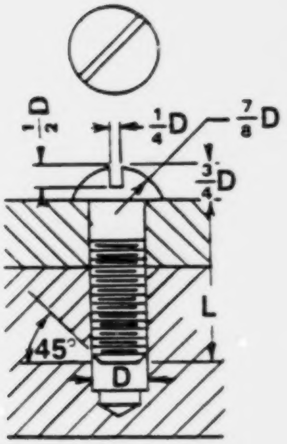
Hexagon Head



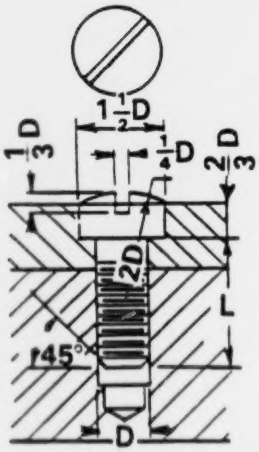
Flat Head



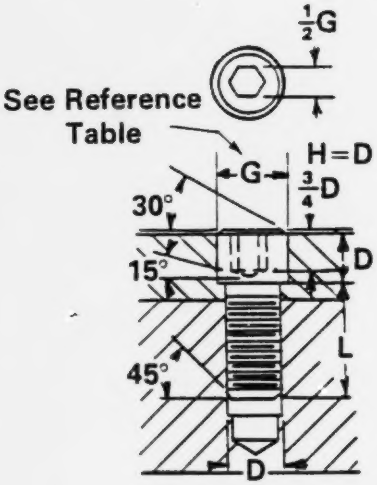
Spline Socket Flat Head



Round Head



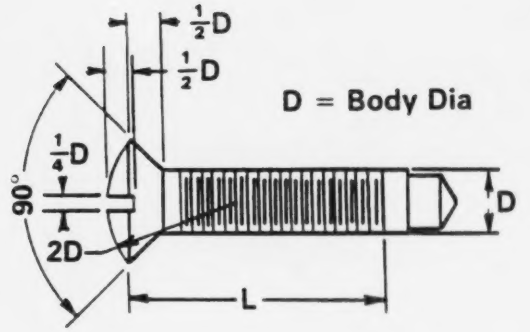
Fillister Head



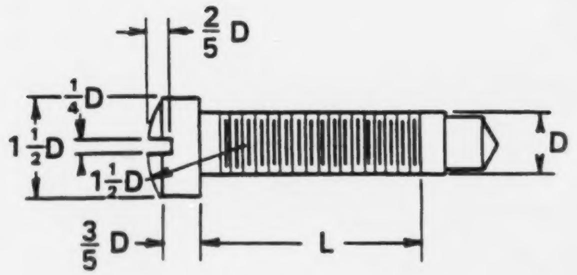
Hex Socket

13?
BEST COPY AVAILABLE

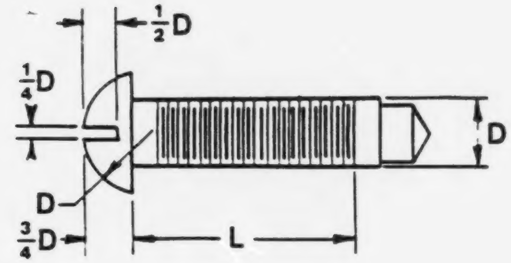
MACHINE SCREWS



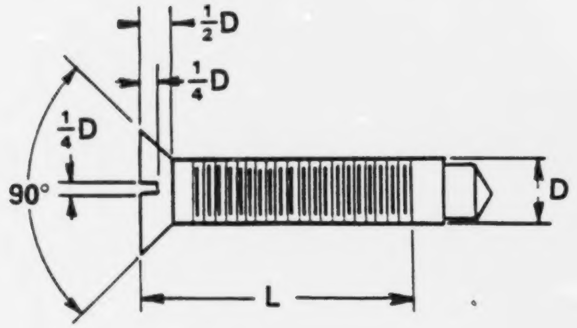
Oval Head



Fillister Head



Round Head

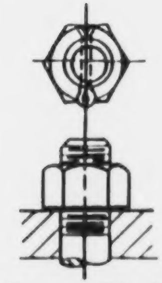


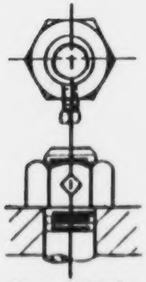
Flat Head

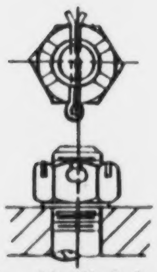
(NOTE: These are approximate dimensions for drawing purposes. Use hardware catalog for accurate dimensions.)

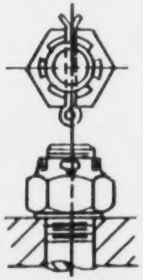
13

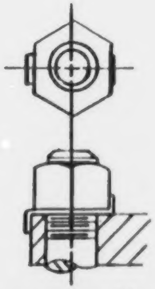
LOCKNUTS AND LOCKING DEVICES

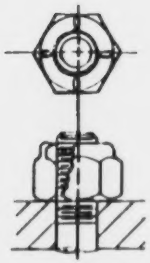

Cotter Pin Hex Semi-Finished Thick Nut

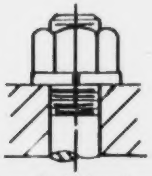

Nut With Set Screw

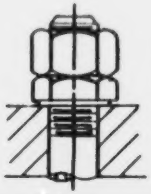

Hex Unfinished Slotted Nut With Cotter Pin

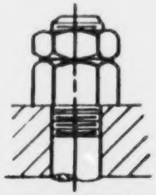

Semi-Finished Castle Nut With Cotter Pin

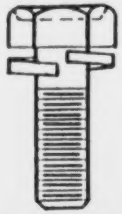

Hexagon Nut with Lock

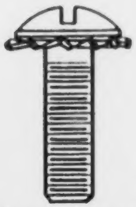

Stop Nut

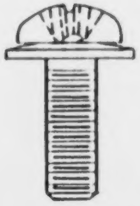

Lock Washer


Hex Semi-Finished Jam Nut


Hex Unfinished Jam Nut


Hexagon Head Screw and Spring Lock Washer


Truss Head Screw and External Tooth Lock Washer


Pan Head Screw and Conical Spring Washer

Screw and Washer Assemblies

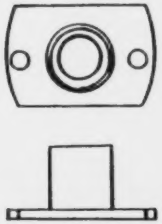
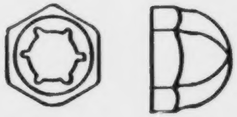
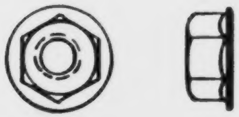
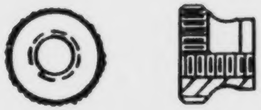
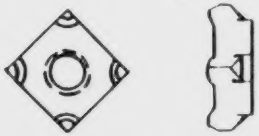


Plate Nut


Stamped Nut


Flange Nut


Knurled Nut


Weld Nut

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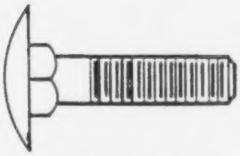
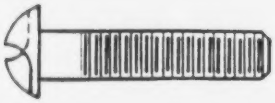
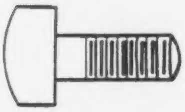
MISCELLANEOUS BOLTS AND SCREWS



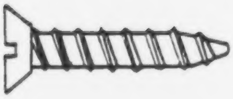
Step Bolt



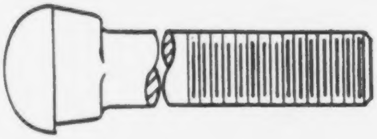
One-Way Head Screw



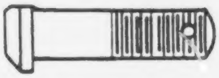
Meter Bolt



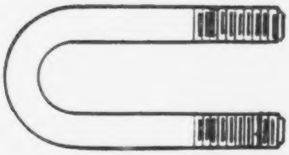
Tapping Screw



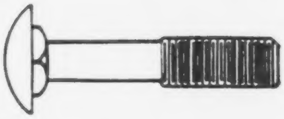
Oval Head Truck Bolt



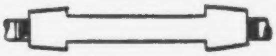
Connecting Rod Bolt



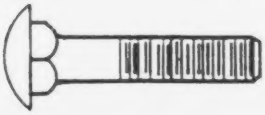
U-Bolt, Round Bend



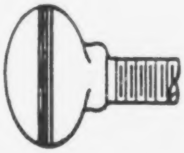
Round Head Short Square Neck Bolt



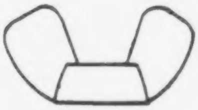
Turnbuckle



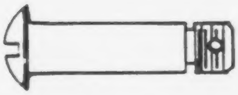
Round Head Square Neck Bolt



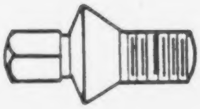
Thumb Screw



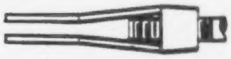
Wing Nut



Clevis Bolt

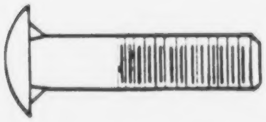


Boiler Patch Bolt

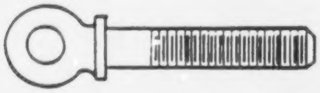


Clevis

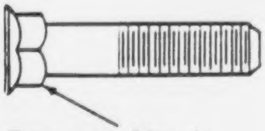
MISCELLANEOUS BOLTS AND SCREWS (continued)



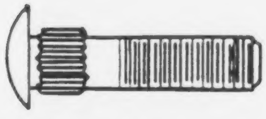
Round Head Fin Neck Bolt



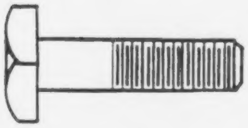
Collared Eye Bolt



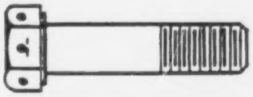
Square Neck



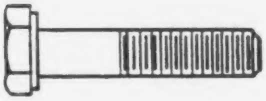
Round Head Ribbed Neck Bolt



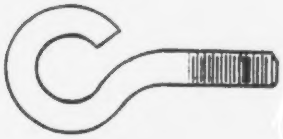
Square Head Bolt



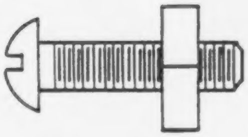
Aircraft Drilled Head Bolt



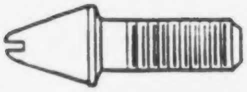
Hexagon Head



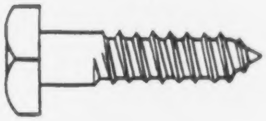
Eye Bolt, Open Anchor Ring



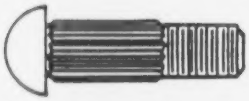
Stove Bolt



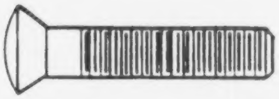
Hood Latch Bolt



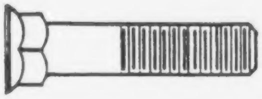
Lag Bolt



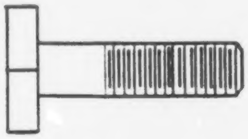
Rivet Bolt



Strut Bolt

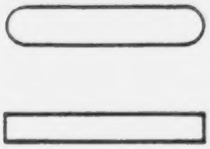


Round Countersunk Head Square Neck Plow Bolt

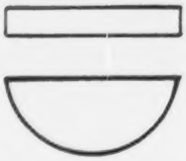


T-Bolt

SHAFT LOCKING HARDWARE

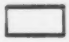


Round End Key
(Pratt and Whitney)

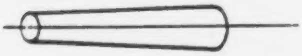


Woodruff
Key

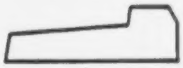
Square
Key



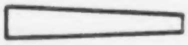
Flat
Key



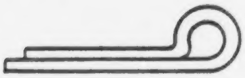
Taper
Key



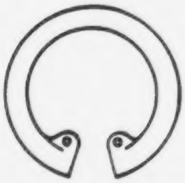
Gib Head
Key



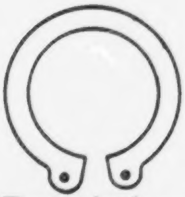
Taper
Pin



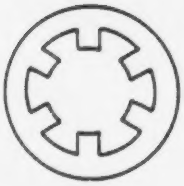
Cotter Pin



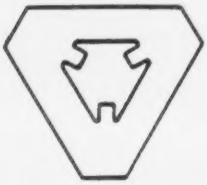
Retaining
Ring
Internal



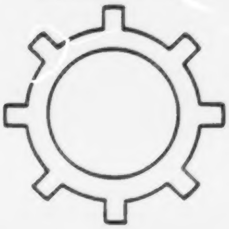
Retaining
Ring
External



Self Locking
External

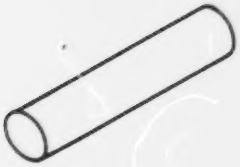


Self Locking
Triangular

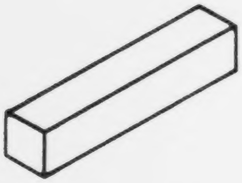


Self Locking
Internal

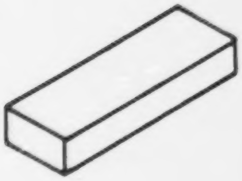
KEYS



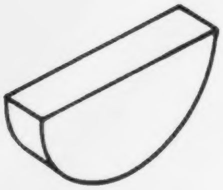
Round



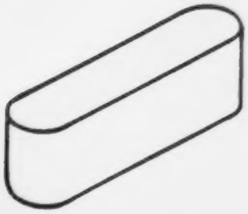
Square



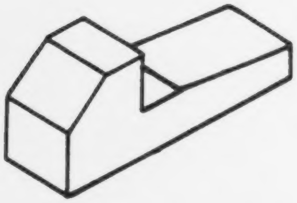
Flat



Woodruff

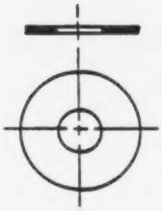


Pratt and Whitney

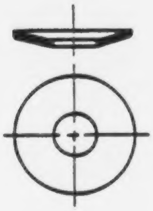


Gib Head

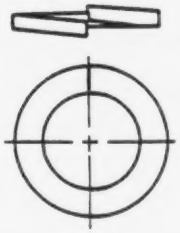
WASHERS



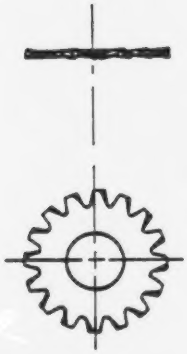
Flat



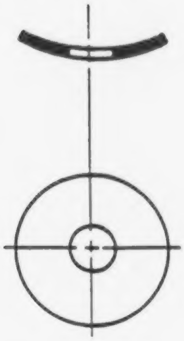
Conical



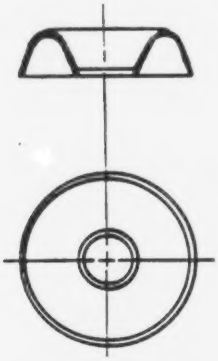
Helical Spring



Tooth Lock

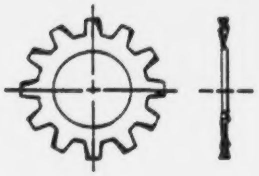


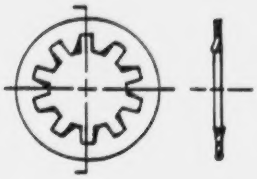
Spring Type

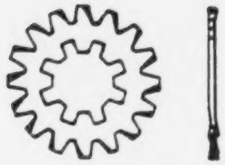


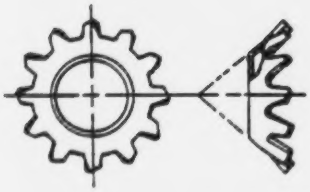
Finishing

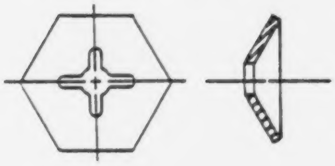
TOOTH LOCK WASHERS


External


Internal


External-Internal

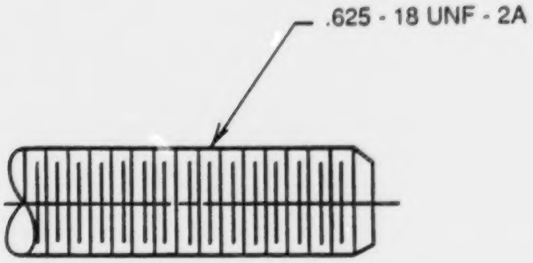

Countersunk


Pyramidal

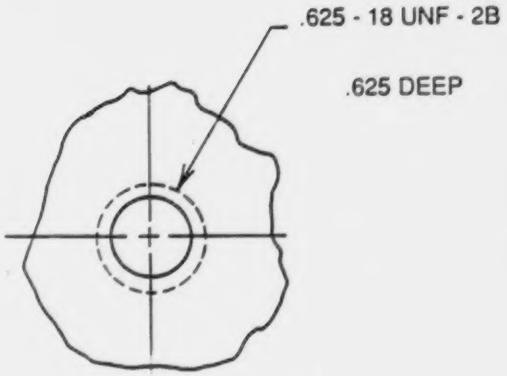
CONSTRUCT THREAD SYMBOLS

Directions: Using the screw thread tables included with this assignment sheet, draw on "B" size vellum or other media to a full or proper scale the thread symbols indicated in the problems. Use the correct type of symbol, and letter the correct thread note as shown in the following example.

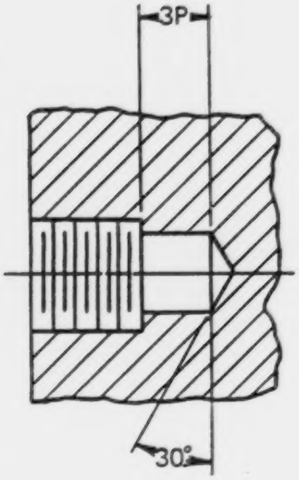
Example:



Schematic



Circular View



Section

Problems:

a. Simplified external thread .75 - 10 NC - 2 LH

b. Simplified internal thread .75 - 10 NC - 2 LH - 1.00 deep

c. Schematic external thread .25 - 20 UNC - 2 A

d. Schematic internal thread .25 - 20 UNC - 2 B through

TABLE 1-A

AMERICAN NATIONAL STANDARD UNIFIED AND AMERICAN NATIONAL SCREW THREADS

Nominal Diameter	Coarse[2] NC UNC		Fine[2] NF UNF		Extra Fine[4] NEF UNEF	
	Thds. per Inch	Tap Drill[5]	Thds. per Inch	Tap Drill[5]	Thds. per Inch	Tap Drill[5]
0 (.060)			80	3/64		
1 (.073)	64	No. 53	72	No. 53	....	....
2 (.086)	56	No. 50	64	No. 50	....	....
3 (.099)	48	No. 47	56	No. 45	....	....
4 (.112)	40	No. 43	48	No. 42	....	....
5 (.125)	40	No. 38	44	No. 37	....	....
6 (.138)	32	No. 36	40	No. 33	....	....
8 (.164)	32	No. 29	36	No. 29	....	....
10 (.190)	24	No. 25	32	No. 21	....	....
12 (.216)	24	No. 16	28	No. 14	32	No. 13
1/4	20	No. 7	28	No. 3	32	7/32
5/16	18	F	24	I	32	9/32
3/8	16	5/16	24	Q	32	11/32
7/16	14	U	20	25/64	28	13/32
1/2	13	27/64	20	29/64	28	15/32
9/16	12	31/64	18	33/64	24	33/64
5/8	11	17/32	18	37/64	24	37/64
11/16	...	......	...	......	24	41/64
3/4	10	21/32	16	11/16	20	45/64
13/16	...	......	...	......	20	49/64
7/8	9	49/64	14	13/16	20	53/64
15/16	...	......	...	......	20	57/64
1	8	7/8	12	59/64	20	61/64
1 1/16	...	......	...	......	18	1
1 1/8	7	63/64	12	1 3/64	18	1 5/64
1 3/16	...	......	...	......	18	1 9/64
1 1/4	7	1 7/64	12	1 11/64	18	1 3/16
1 5/16	...	....	...	....	18	1 17/64
1 3/8	6	1 7/32	12	1 19/64	18	1 5/16
1 7/16	...	....	...	....	18	1 3/8
1 1/2	6	1 11/32	12	1 27/64	18	1 7/16
1 9/16	...	....	...	....	18	1 1/2
1 5/8	...	....	...	....	18	1 9/16
1 11/16	...	....	...	....	18	1 5/8
1 3/4	5	1 9/16	...	....	...	....
2	4 1/2	1 25/32	...	....	...	....
2 1/4	4 1/2	2 1/32	...	....	...	....
2 1/2	4	2 1/4	...	....	...	....
2 3/4	4	2 1/2	...	....	...	....
3	4	2 3/4	...	....	...	....
3 1/4	4	....	...	....	...	....
3 1/2	4	....	...	....	...	....
3 3/4	4	....	...	....	...	....
4	4	....	...	....	...	....

[1] ANSI B1.1

[2] Classes 1A, 2A, 3A, 1B, 2B, 3B, 2 and 3

[3] Classes 2A, 3A, 2B, 3B, 2 and 3

[4] Classes 2A, 2B, 2 and 3

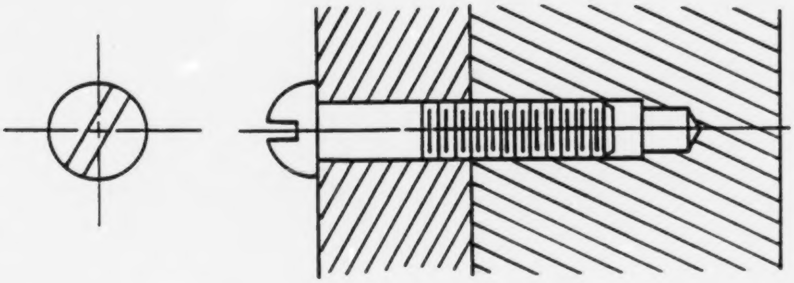
[5] For approximate 75% full depth of thread

Nominal Diameter	8-Pitch[3] Series 8N and 8UN		12-Pitch[3] Series 12N and 12UN		16-Pitch[3] Series 16N and 16UN	
	Thds. per Inch	Tap Drill[5]	Thds. per Inch	Tap Drill[5]	Thds. per Inch	Tap Drill[5]
1/2	....	....	12	27/64	...	......
9/16	....	....	12	31/64	...	......
5/8	....	....	12	35/64		...
11/16	....	....	12	39/64	...	.....
3/4	....	....	12	43/64	16	11/16
13/16	....	....	12	47/64	16	3/4
7/8	....	....	12	51/64	16	13/16
5/16	....	....	12	55/64	16	7/8
1	8	7/8	12	59/64	16	15/16
1 1/16	....	....	12	63/64	16	1
1 1/8	8	1	12	1 3/64	16	1 1/16
1 3/16	....	....	12	1 7/64	16	1 1/8
1 1/4	8	1 1/8	12	1 11/64	16	1 3/16
1 5/16	....	....	12	1 15/64	16	1 1/4
1 3/8	8	1 1/4	12	1 19/64	16	1 5/16
1 7/16	....	....	12	1 23/64	16	1 3/8
1 1/2	8	1 3/8	12	1 27/64	16	1 7/16
1 9/16	....	....	...	....	16	1 1/2
1 5/8	8	1 1/2	12	1 35/64	16	1 9/16
1 11/16	....	....	...	....	16	1 5/8
1 3/4	8	1 5/8	12	1 43/64	16	1 11/16
1 13/16	....	....	...	....	16	1 3/4
1 7/8	8	1 3/4	12	1 51/64	16	1 13/16
1 15/16	....	....	...	....	16	1 7/8
2	8	1 7/8	12	1 59/64	16	1 15/16
2 1/16	....	....	...	....	16	2
2 1/8	....	....	12	2 3/64	16	2 1/16
2 3/16	....	....	...	....	16	2 1/8
2 1/4	8	2 1/8	12	2 11/64	16	2 3/16
2 5/16	....	....	...	....	16	2 1/4
2 3/8	....	....	12	2 19/64	16	2 5/16
2 7/16	....	....	...	....	16	2 3/8
2 1/2	8	2 3/8	12	2 27/64	16	2 7/16
2 5/8	....	....	12	2 35/64	16	2 9/16
2 3/4	8	2 5/8	12	2 43/64	16	2 11/16
2 7/8	....	....	12	....	16	....
3	8	2 7/8	12	....	16	....
3 1/8	....	....	12	....	16	....
3 1/4	8	....	12	....	16	....
3 3/8	....	....	12	....	16	....
3 1/2	8	....	12	....	16	....
3 5/8	....	....	12	....	16	....
3 3/4	8	....	12	....	16	....
3 7/8	....	....	12	....	16	....
4	8	....	12	....	16	....
4 1/4	8	....	12	....	16	....
4 1/2	8	....	12	....	16	....
4 3/4	8	...	12	....	16	....
5	8	....	12	....	16	....
5 1/4	8	....	12	....	16	....

CONSTRUCT BOLTS, SCREWS, AND NUTS

Directions: Using bolt, screw, and nut tables, draw on "B" size vellum or other media to a full or proper scale the fasteners indicated in the problems. Each fastener is to be drawn holding parts together. Letter correct description abbreviated below each symbol as shown in the following example.

Example:



Problems:

NOTE: All tap drill sizes should be specified for external.

a. 3/4 x 2 1/2 hexagon head cap screw

b. 5/8 - 11UNC - 2B square nut

c. 3/4 - 10UNC - 2A 2 1/2 long hexagon cap screw

d. No. 10 (.1900) - 32NF - 3, 5/8 long fillister head machine screw

e. 3/8 - 16UNC - 2A, 3/4 long square head flat point set screw

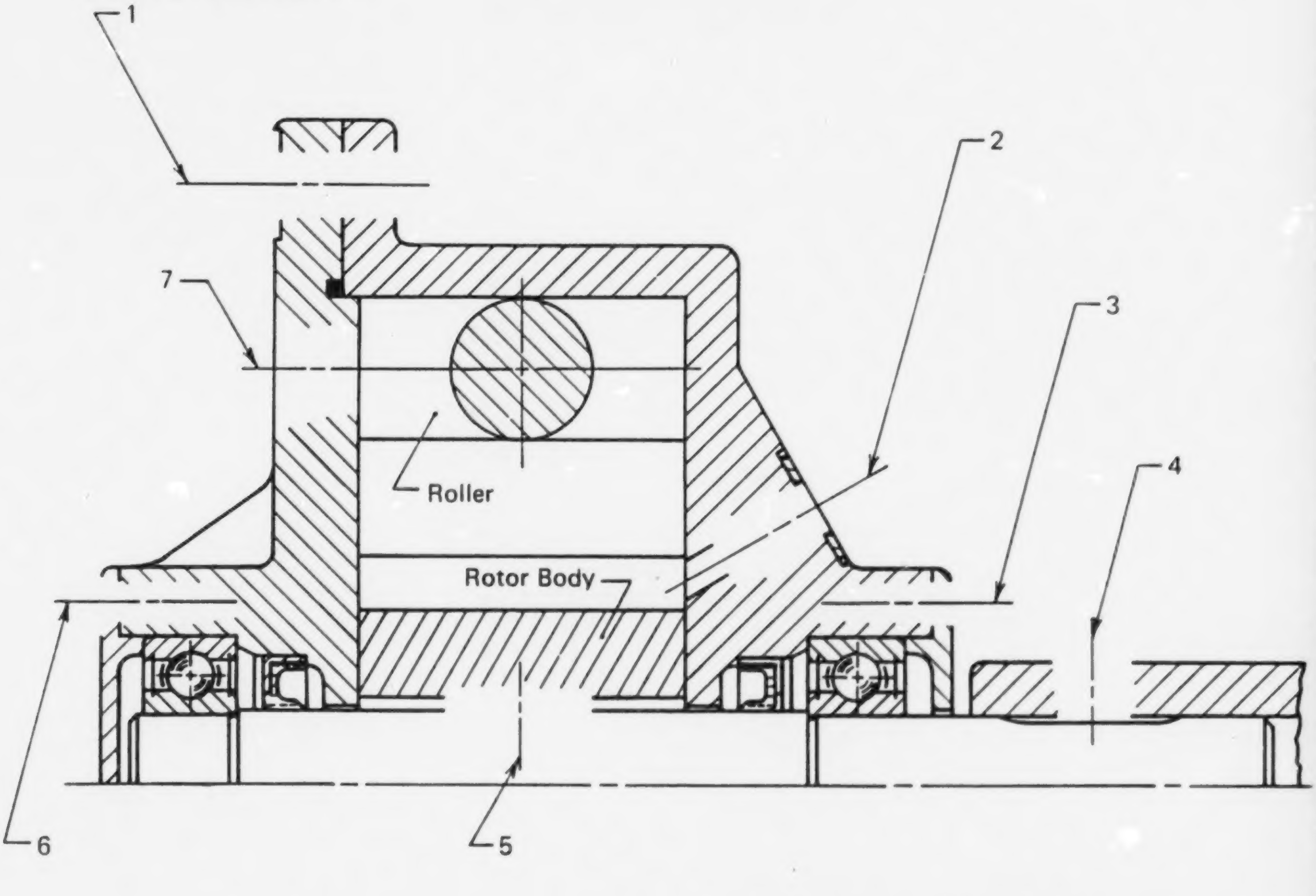
f. #204 woodruff key

CONSTRUCT AN ASSEMBLY CONTAINING VARIOUS FASTENERS

Directions: Using fastener tables, draw on "B" size vellum or other media an assembly drawing with the following fasteners:

1. 3/8 x 1" hexagon cap screw and American Standard regular lockwasher
2. 3/8 x 1/2 slotted pan head machine screw and special washer
3. No. 10 x 1/2 slotted round head machine screw
4. 3/8 x 1/2 slotted headless cup point set screw
5. #606 Woodruff key
6. #10 x 1/2 slotted oval head machine screw
7. 3/4 pipe tap

Letter correct fastener descriptions in parts list directly above title block. Complete the sectioned assembly as specified by instructor.

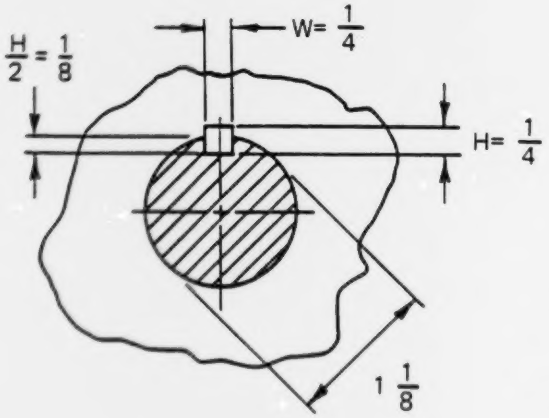


CONSTRUCT KEYS IN ASSEMBLED POSITIONS

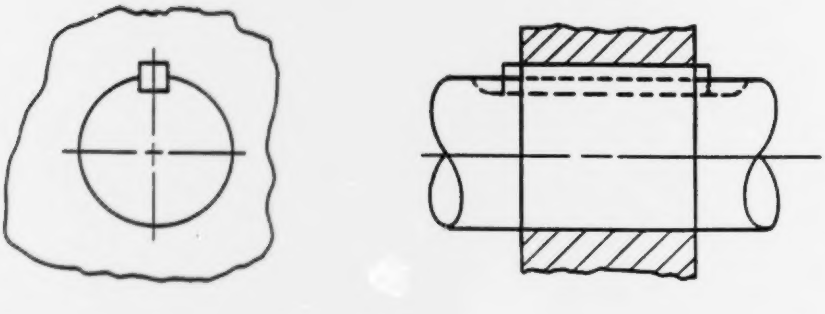
Directions: Using the tables included with this assignment sheet, construct keys for the problems given by using the procedure in the following example.

Example: Construct an assembled detailed drawing of a 1 1/8" shaft square keyed to a wheel. Only show detail of the key, shaft, and wheel.

1. Using Table 6-C, find shaft diameter range for 1 1/8" shaft
2. Answer is 15/16" to 1 1/4"
3. Reading across the line, square stock key says W = 1/4 and H = 1/4
4. Draw detail based on dimensions in illustration



DRAWING INFORMATION



DRAWING

Problems:

A. Construct an assembled detailed drawing of a 1 1/2" diameter shaft square keyed to a wheel. Only show detail of the key, shaft, and wheel. Draw in 1/2" = 1" scale in the upper left quarter of the "A" size vellum. Letter title and scale under detail.

B. Construct an assembled detailed drawing of a 4 3/4" diameter shaft flat keyed to a wheel. Only show detail of the key, shaft, and wheel. Draw in 1/4" = 1' scale in the upper right quarter of the "A" size vellum. Letter title and scale under detail.

C. Construct an assembled detailed of a 9/16" diameter shaft Woodruff keyed to a pulley. Only show detail of the key, shaft, and pulley. Draw in 2 x scale in the lower left quarter of the "A" size vellum. Letter title and scale under detail.

NOTE: Table 6-A will locate the Woodruff key size and Table 6-B will give the drawing details.

D. Construct an assembled detailed drawing of a 1 3/4" diameter shaft Woodruff keyed to a hub. Only show detail of the key, hub, and shaft. Draw in full size in the lower right quarter of the "A" size vellum. Letter title and scale under detail.

Table 6-A

Woodruff Keys[1] - American National Standard

Key No.[2]	Nominal Sizes				Maximum Sizes		
	A X B	E	F	G	H	D	C
204	1/16 X 1/2	3/64	1/32	5/64	.194	.1718	.203
304	3/32 X 1/2	3/64	3/64	3/32	.194	.1561	.203
305	3/32 X 5/8	1/16	3/64	7/64	.240	.2031	.250
404	1/8 X 1/2	3/64	1/16	7/64	.194	.1405	.203
405	1/8 X 5/8	1/16	1/16	1/8	.240	.1875	.250
406	1/8 X 3/4	1/16	1/16	1/8	.303	.2505	.313
505	5/32 X 5/8	1/16	5/64	9/64	.240	.1719	.250
506	5/32 X 3/4	1/16	5/64	9/64	.303	.2349	.313
507	5/32 X 7/8	1/16	5/64	9/64	.365	.2969	.375
606	3/16 X 3/4	1/16	3/32	5/32	.303	.2193	.313
607	3/16 X 7/8	1/16	3/32	5/32	.365	.2813	.375
608	3/16 X 1	1/16	3/32	5/32	.428	.3443	.438
609	3/16 X 1 1/8	5/64	3/32	11/64	.475	.3903	.484
807	1/4 X 7/8	1/16	1/8	3/16	.365	.2500	.375
808	1/4 X 1	1/16	1/8	3/16	.428	.3130	.438
809	1/4 X 1 1/8	5/64	1/8	13/64	.475	.3590	.484
810	1/10 X 1 1/4	5/64	1/8	13/64	.537	.4220	.547
811	1/4 X 1 3/8	3/32	1/8	7/32	.584	.4690	.594
812	1/4 X 1 1/2	7/64	1/8	15/64	.631	.5160	.641
1008	5/16 X 1	1/16	5/32	7/32	.428	.2818	.438
1009	5/16 X 1 1/8	5/64	5/32	15/64	.475	.3278	.484
1010	5/16 X 1 1/4	5/64	5/32	15/64	.537	.3908	.547
1011	5/16 X 1 3/8	3/32	5/32	8/32	.584	.4378	.594
1012	5/16 X 1 1/2	7/64	5/32	17/64	.631	.4848	.641
1210	3/8 X 1 1/4	8/64	3/16	17/64	.537	.3595	.547
1211	3/8 X 1 3/8	3/32	3/16	9/32	.584	.4065	.594
1212	3/8 X 1 1/2	7/64	3/16	19/64	.631	.4335	.641

[1] ANSI B17.2-1967, R1972

[2] Key numbers indicate nominal key dimensions. The last two digits give the nominal diameter B in eighths of an inch, and the digits before the last two give the nominal width A in thirty-seconds of an inch.

MODULE: INTRODUCTION TO PRODUCTION/MANUFACTURING DRAFTING

UNIT II: INTRODUCTION TO MACHINE DRAWINGS

LESSON 3: FASTENERS AND HARDWARE

ANSWERS TO ASSIGNMENT SHEETS

All assignment sheets should be evaluated to the satisfaction of the instructor.

MODULE: INTRODUCTION TO PRODUCTION/MANUFACTURING DRAFTING

UNIT II: INTRODUCTION TO MACHINE DRAWINGS

UNIT TEST

Lesson 1
Match the terms on the right with the correct definitions.

____ 1. Change made on a drawing

____ 2. Equal intervals along the margins labeled with numbers along the horizontal margin and with letters along the vertical margin for locating an area on a drawing

____ 3. Drawing containing the necessary information to completely manufacture a single part or one stage of a single part

____ 4. Name of the object or project

____ 5. Area to show all information related to a drawing revision

____ 6. Organized method to combine scientific principles, standard parts, and resources into the solution of a problem

____ 7. Drawing showing all parts in their working positions

____ 8. Standardized place to show all information not shown with notes and dimensions on the drawing

____ 9. Combined detail and assembly drawing used when the details are simple enough for all parts to be shown and dimensioned clearly while shown in assembled positions

____ 10. Accurate drawing of all parts in working positions showing clearances of moving parts, ease of assembly, and ease of serviceability

____ 11. Itemized list of parts shown with an assembly drawing

____ 12. A detail drawing of a workpiece to be cast

____ 13. A detail drawing of a workpiece to be forged in dies

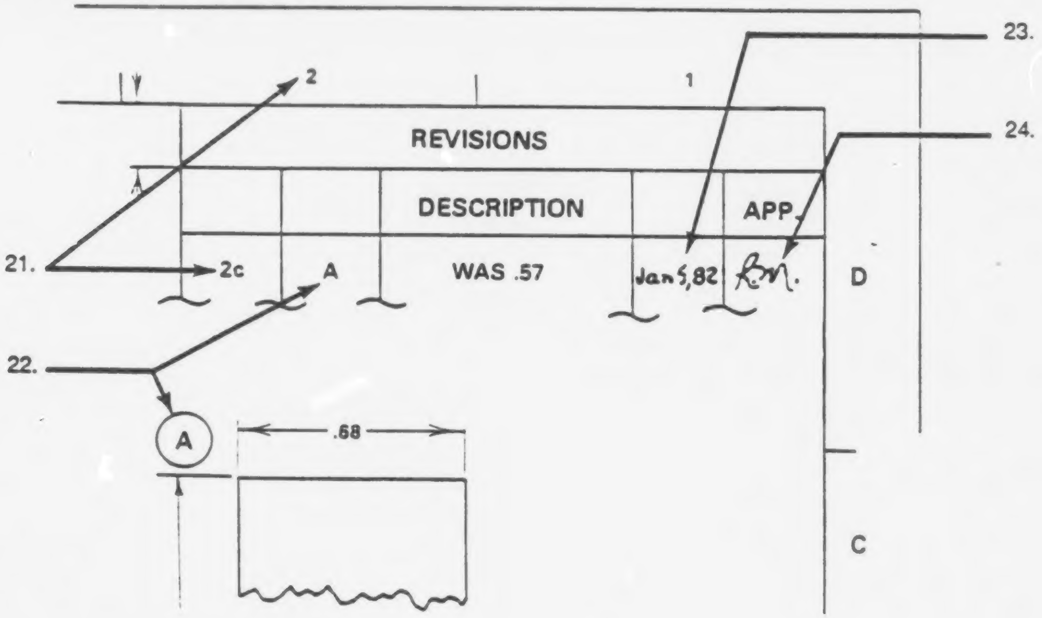
____ 14. An approved change to a drawing caused by a change in design, tool changes, errors in design

a. Title
b. Title form
c. Revision
d. Engineering change notice
e. Revision Form
ab. Zoning
ac. Bill of materials/parts list
ad. Casting drawing
ae. Design layout
bc. Design process
bd. Detail drawing
be. Assembly drawing
cd. Forging drawing
ce. Detail assembly drawing

Distinguish between standard and additional information on a title form by placing an "a" next to the standard information and a "b" next to the additional information.

15. ____ Tolerances
16. ____ Revision letter
17. ____ Signature of drafter with date of completion
18. ____ Hardness
19. ____ Heat treatment
20. ____ Predominate scale of drawing

Identify information on a revision block.



21. ______________________
22. ______________________
23. ______________________
24. ______________________

25. List information on a bill of materials/parts list.

   a. Standard information

      1) ____________________

      2) ____________________

   b. Additional information

      1) ____________________

      2) ____________________

      3) ____________________

      4) ____________________

26. Name the three standard parts of a detail drawing.

   a. ____________________

   b. ____________________

   c. ____________________

Match the parts of an assembly drawing on the right with the correct function.

27. ____ Shown only to promote clearness; unnecessary when several sections are used

28. ____ Allow for quick identification of physical shape and guide reader to the parts list

29. ____ Show maximum or minimum sizes or locations of machine parts after assembly and overall size

30. ____ Show relationship of parts

31. ____ Show the inside function or construction of the parts

a. Views

b. Sections

c. Hidden lines

d. Dimensions

e. Parts identification numbers

Lesson 2

Match the terms on the right with the correct definitions.

32. ____ The condition that refers to a part made to limit dimensions so that it will fit any part similarly manufactured; the ability of mating parts to fit properly together

33. ____ Any type of dimension that tells how large or small an object is

34. ____ The size of a part determined by engineering and design requirements from which the limits of size are determined; the line of zero deviation

35. ____ The extreme permissible dimensions of a part resulting from the application of a tolerance; the maximum and minimum size indicated by a tolerance

36. ____ Used when maximum material is present in a feature

37. ____ Difference between the maximum limit and the basic size

38. ____ Difference between the minimum limit and the basic size

39. ____ The deviation nearer the basic size for the hole and near the basic size for the shaft

40. ____ The basic size of the shaft is the design size and the allowance is applied to the hole

41. ____ Limits of size are determined so that a negative allowance or tight fit occurs between mating parts

42. ____ Limits of size are determined so that the allowance may be either a clearance fit or an interference fit

43. ____ Exact theoretical position of a feature established by basic dimensions

44. ____ Direction of the major surface pattern determined by manufacturing method used

45. ____ Widely spaced element of a surface texture

a. Limits
b. Interference fit
c. Waviness
d. Lower deviation
e. Basic shaft system
ab. Positional tolerance
ac. Lay
ad. Interchangeability
ae. Transition fit
bc. Maximum material condition
bd. Basic size
be. Fundamental deviation
cd. Size dimension
ce. Upper deviation

46. ____ Shapes such as prisms, cylinders, pyramids, cones, and spheres

47. ____ Any type of dimension that locates a feature on an object

48. ____ The total amount of variation permitted in limit dimensioning of a part; the difference between the limit dimensions

49. ____ Used when the least material is present in a feature

50. ____ Group of tolerances numbered 01-16

51. ____ The association of a fundamental deviation with an international tolerance grade

52. ____ The basic size of the hole is the design size and the allowance is applied to the shaft

53. ____ Limits of size are determined so that a loose fit or positive allowance occurs between mating parts

54. ____ The minimum international difference in the dimensions of mating parts to provide for different classes of fits; the minimum clearance or maximum interference when parts are at maximum material condition

55. ____ Points, lines, or other geometric shapes assumed to be exact from which the location or geometric form of features of a part may be established

56. ____ Maximum allowable variations of a perfect geometric shape

57. ____ Roughness, waviness, and lay of a surface which may include certain flaws

58. ____ Fine irregularities in surface texture

59. ____ Measurements of the human body and its parts

a. Clearance fit

b. Basic hole system

c. Roughness

d. Allowance

e. Anthropometric data

ab. Tolerance

ac. Surface quality

ad. Location dimension

ae. Datums

bc. Least material condition

bd. International tolerance grade

be. Form tolerances

cd. Geometric shapes

ce. Tolerance zone

60. ____ Measurements given on a drawing such as size and location

61. ____ A portion of a part, such as a diameter, hole, keyway, or flat surface

62. ____ Method of dimensioning where only the maximum and minimum dimensions are given

63. ____ Successive dimensions that extend from one feature to another, rather than each originating at a datum

64. ____ A theoretically exact value used to describe the size, shape, or location of a feature

65. ____ The variations permitted are in both directions from the specified dimensions

66. ____ Degree of tightness or looseness between mating parts

67. ____ The size of a feature after an allowance for clearance has been applied and tolerances have been assigned

68. ____ System designed to control dimensions to allow interchangeability in manufacturing

69. ____ The variation is in only one direction from the specified dimensions

70. ____ The classification size given to manufactured products such as pipe or lumber

71. ____ Method where features are dimensioned individually from a datum

72. ____ Untoleranced dimensions placed on drawings for the convenience of engineering and manufacturing

73. ____ The measured size of an object

74. ____ The extent to which or the range in which a dimension or size varies

a. Bilateral tolerance

b. Chain dimensioning

c. Datum dimensioning

d. Design size

e. Dimension

ab. Feature

ac. Actual size

ad. Basic dimension

ae. Unilateral tolerance

bc. Fit

bd. Limit dimensioning

be. Nominal size

cd. Reference dimension

ce. Tolerancing

de. Variation

Distinguish between size and location dimensions for the following geometric shapes by placing an "a" next to the size dimensions and a "b" next to the location dimensions.

75. ___ Dimension "A"

76. ___ Dimension "B"

77. ___ Dimension "C"

78. ___ Dimension "D"

79. ___ Dimension "E"

80. ___ Dimension "F"

81. ___ Dimension "G"

82. ___ Dimension "H"

83. ___ Dimension "I"

84. ___ Dimension "J"

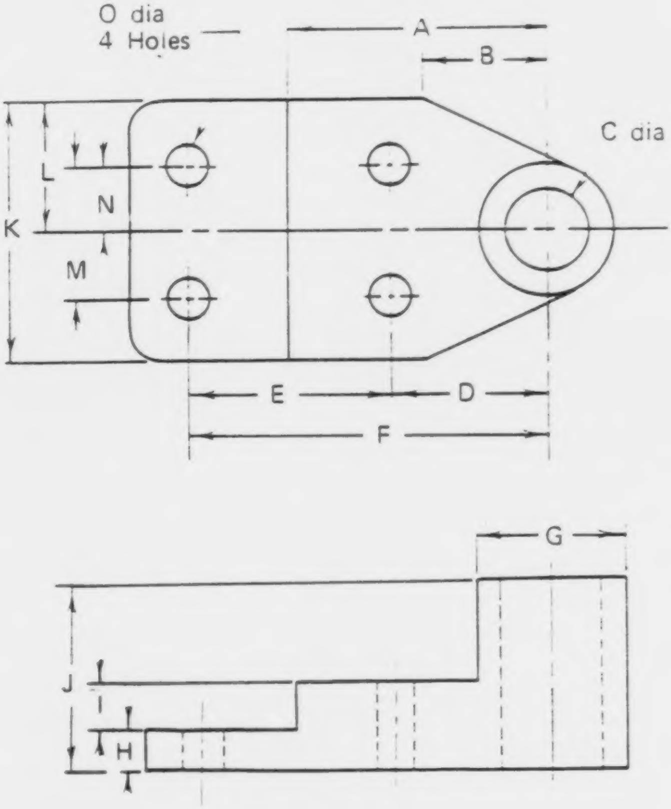
85. ___ Dimension "K"

86. ___ Dimension "L"

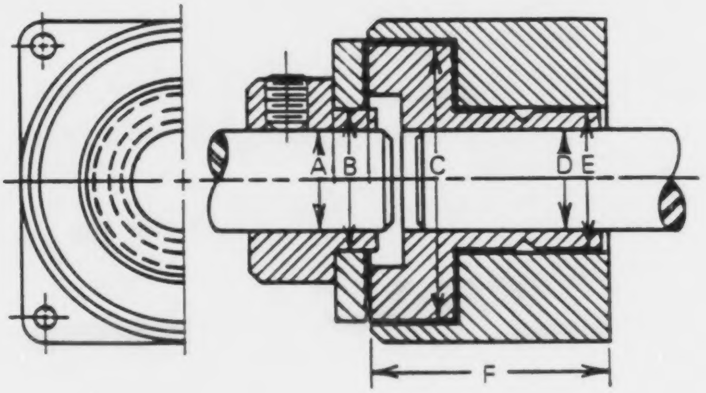
87. ___ Dimension "M"

88. ___ Dimension "N"

89. ___ Dimension "O"



Select mating dimensions in the following assembly drawing by placing an "a" in the appropriate blanks.



90. ___ Dimension "A"

91. ___ Dimension "B"

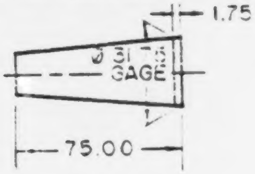
92. ___ Dimension "C"

93. ___ Dimension "D"

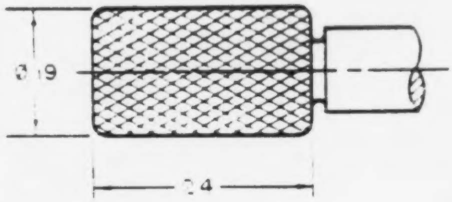
94. ___ Dimension "E"

95. ___ Dimension "F"

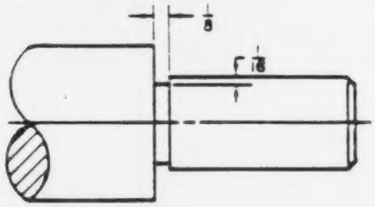
96. Identify various standard machine manufactured features.



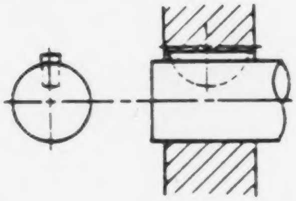
a. ____________________



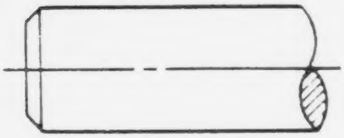
b. ____________________



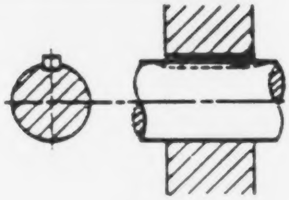
c. ____________________



d. ____________________



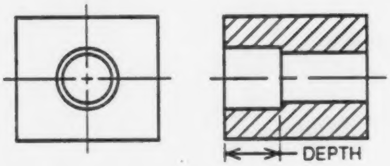
e. ____________________



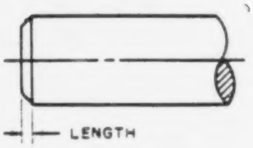
f. ____________________

Write proper dimension notes for standard machine manufactured features.

97. Countersink Diameter of second drill, 3/4 and 7/16 deep; diameter of first drill, 1/2

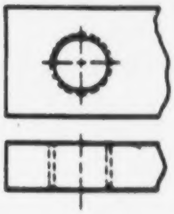


98. Chamfer--Length of offset, 1/16; 45°



99. Internal thread, through-drill--

1) 3/4-fractional size of tap drill
2) 7/8-Nominal thread diameter
3) 1-Class 1 thread fit
4) UN-Unified thread fit
5) 12-Threads per inch
6) F-Fine thread series



100. Illustrate the systems of dimensioning tolerances on drawings.

a. Limits

b. Plus and minus

c. Notes

Select true statements concerning numerical control dimensioning by placing an "a" in the appropriate blanks. Place a "b" in the blanks of false statements.

101. ____ Datum or reference planes must be selected that are mutually perpendicular in the X, Y, and Z axes

102. ____ Dimensions originate from two planes

103. ____ Dimensions must be in fractions

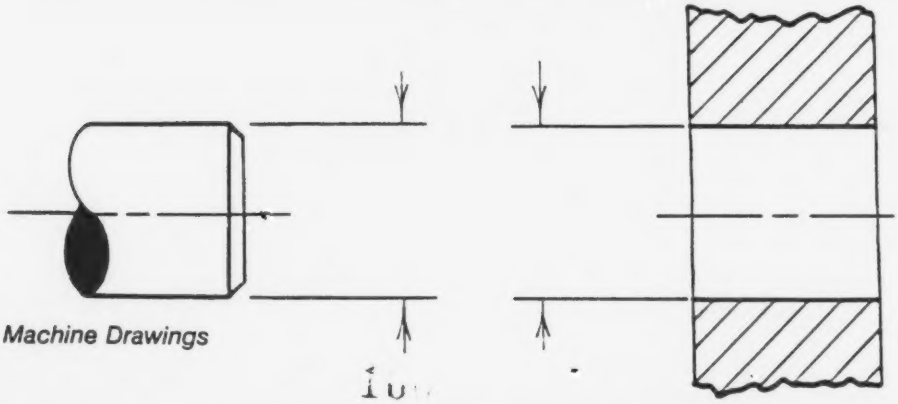
104. ____ Standard tools such as reamers, drills, and tapers should be specified wherever possible

Identify the category of fit by placing the appropriate letter in each blank.

105.	____	RC 2	a.	Running-sliding fit
106.	____	H9/d9	b.	Locational fit
107.	____	H7/h6	c.	Force fit
108.	____	FN 3		
109.	____	LT 1		
110.	____	N7/h6		
111.	____	P7/h6		
112.	____	U7/h6		
113.	____	LC1		

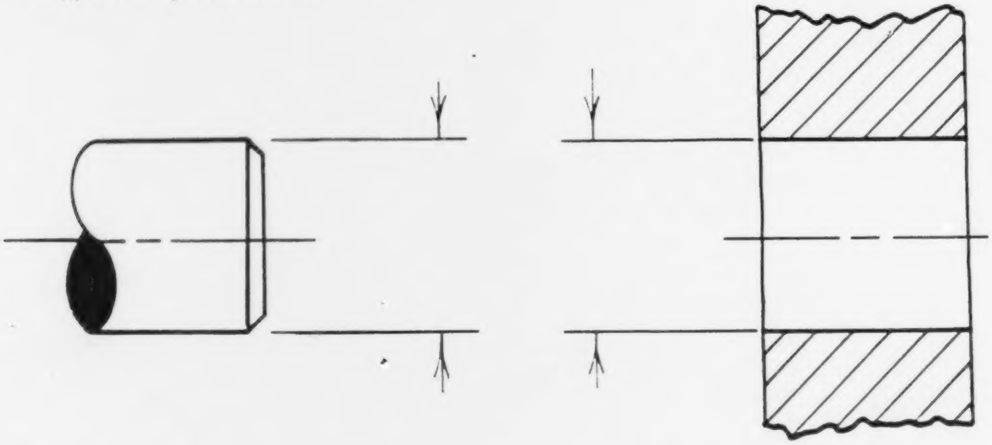
114. Calculate the limits for clearance fit in inch units using basic hole system for basic hole size of 2.25" and RC 4 fit. Place answers on drawing.

	RC 3			RC 4			
NOMINAL SIZE RANGE, INCHES	LIMITS OF CLEARANCE	STANDARD LIMITS HOLE	STANDARD LIMITS SHAFT	LIMITS OF CLEARANCE	STANDARD LIMITS HOLE	STANDARD LIMITS SHAFT	
1.19 - 1.97	- 1.0 - 2.6	+ 1.0 - 0	- 1.0 - 1.6	1.0 3.6	+ 1.6 - 0	- 1.0 - 2.0	
1.97 - 3.15	1.2 3.1	+ 1.2 - 0	- 1.2 - 1.9	1.2 4.2	+ 1.8 - 0	- 1.2 - 2.4	



115. Calculate the limits for clearance fit in inch units using basic shaft system for basic shaft size of 1.75 and RC 3 fit. Place answers on drawing.

NOTE: Use table in question 114.



Lesson 3

Match the terms on the right with the correct definitions.

116. ____ Head having a slot centered across the top

117. ____ Fastener having high tensile and shear strength

118. ____ Least amount of drawing information necessary to convey information without confusion

119. ____ Mechanical device for holding two or more parts in a set position

120. ____ Fastener with wide tolerances and all surfaces in their formed conditions

121. ____ Head having a specially formed indentation centered in its top

122. ____ Fastener made to close tolerance having a high grade finish

123. ____ Close approximation to actual appearance

124. ____ More detailed than simplified but faster to draw than detailed threads

125. ____ Fastener made with greater tolerances than a finished fastener and having only the bearing surface and threads finished

126. ____ Profile of the thread

127. ____ Small parts such as fasteners, springs, and washers

128. ____ Used to attach wheels, pulleys, and gears to shafts

129. ____ Designed for fastening, adjusting, and transmitting motion or power

130. ____ Used to seal along a shaft

a. Fastener
b. Keys
c. Finished fastener
d. High strength fastener
e. Semi-finished fastener
ab. Hardware
ac. Unfinished fastener
ad. Slotted head
ae. Recessed head
bc. Nuts
bd. Screw thread form
be. Schematic threads
cd. Simplified threads
ce. Detailed threads
de. O-rings

131. ____ Thread on the inside of a hole

132. ____ Thread having one start, and the lead is equal to the pitch

133. ____ Chemical bonding between parts

134. ____ Advances when turned clockwise

135. ____ Distance a screw travels in one rotation

136. ____ Thread on the outside of a shaft

137. ____ Number of threads per inch based on standard nominal diameters

138. ____ Thread having multiple starts, and the lead is equal to a multiple of the pitch

139. ____ Joining parts by melting base metal to form a unit structure to support loads

140. ____ Advances when turned counterclockwise

141. ____ Used for storage of mechanical energy

142. ____ Designed to insulate, lubricate, span large holes, and distribute stress over a larger area

143. ____ Designed for semi-permanent attachment or location

144. ____ Has a removable shoulder to accurately retain, locate, or lock components in bases and housings or on shafts

a. External thread

b. Internal thread

c. Retaining ring

d. Lead

e. Series of thread

ab. Single thread

ac. Multiple threads

ad. Pins

ae. Springs

bc. Right hand thread

bd. Left hand thread

cd. Welding

ce. Washers

de. Adhesive

Name two general types of fasteners.

145. ____________________

146. ____________________

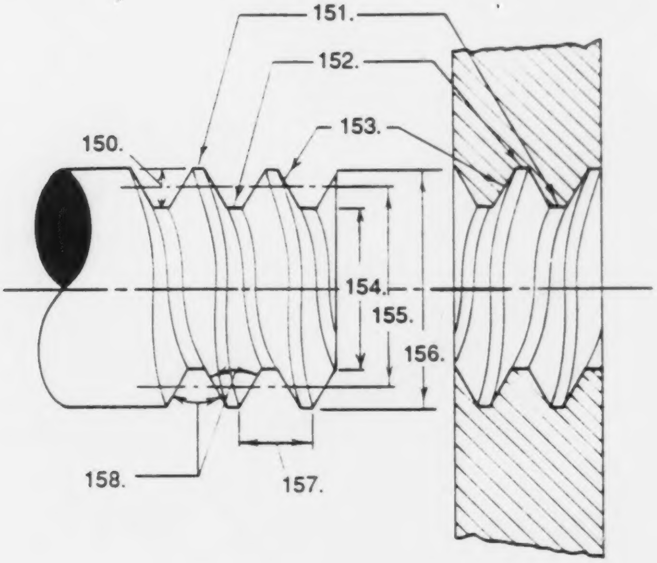
Name three basic applications of screw threads.

147. ____________________

148. ____________________

149. ____________________

Identify screw thread nomenclature.



150. ____________

151. ____________

152. ____________

153. ____________

154. ____________

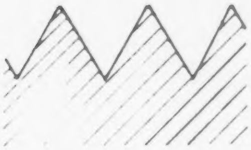
155. ____________

156. ____________

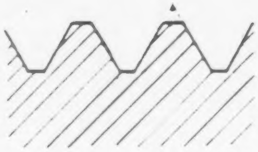
157. ____________

158. ____________

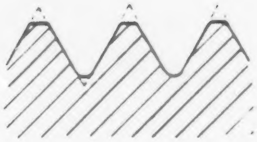
Identify screw thread profiles.



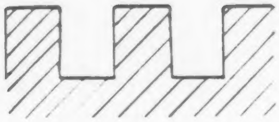
159. ____________



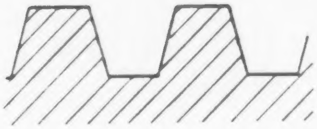
160. ____________



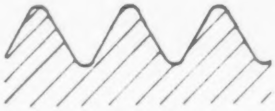
161. ____________



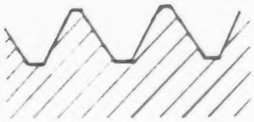
162. ____________



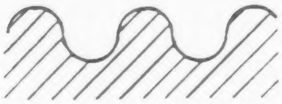
163. ____________



164. ____________



165. ____________



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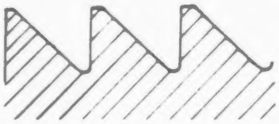


167. ____________

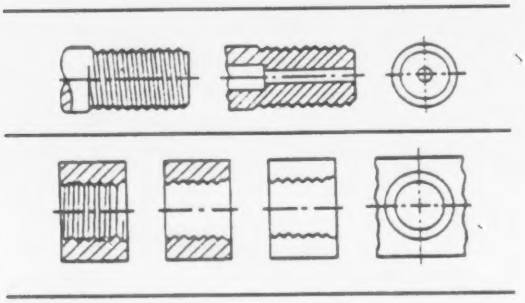
Compute lead of thread for the following problems.

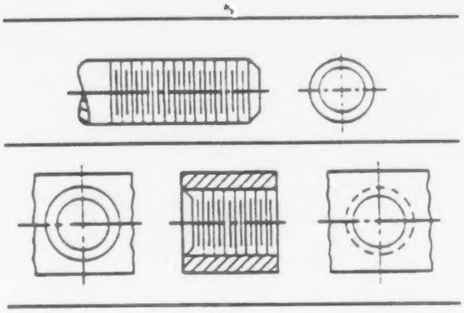
168. Single thread, 10 threads per inch L = ____________

169. Double thread, 18 threads per inch L = ____________

170. Triple thread, 24 threads per inch L = ____________

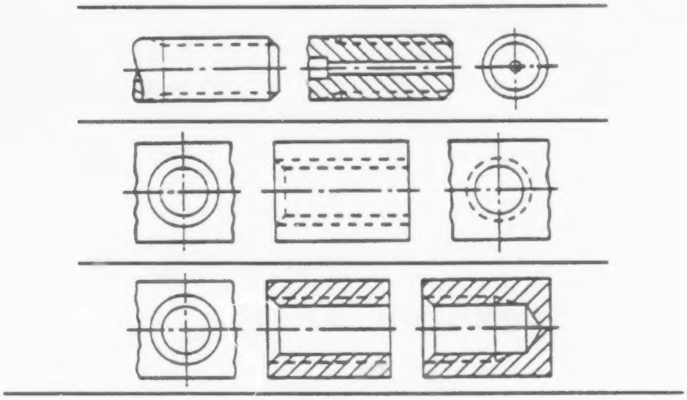
Identify screw thread symbols.





171. ______________________

172. ______________________



173. ______________________

Match classes of fit for unified threads on the right with the correct uses.

___	174.	For general purposes and most common uses	a.	Classes 1A and 1B
___	175.	For close tolerance screw thread	b.	Classes 2A and 2B
___	176.	For parts that are easy to assemble; ordinance and other special uses; quick assembly	c.	Classes 3A and 3B

Identify parts of thread notes.

177. 178. 179. 180. 181.

$\frac{7}{8}$ – 9 NC–2 LH–1.00 DEEP

182. 183. 184. 185. 186.

M 6.3 X 1 6H B LH

177. ____________________ 178. ____________________

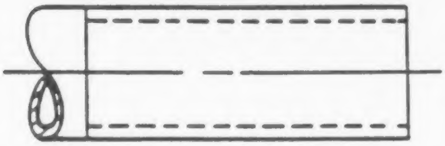
179. ____________________ 180. ____________________

181. ____________________ 182. ____________________

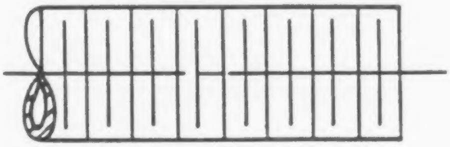
183. ____________________ 184. ____________________

185. ____________________ 186. ____________________

Distinguish between conventional representations by placing an "a" next to the thread drawn in schematic and a "b" next the thread drawn in simplified.



___ 187.



___ 188.

189. **List four types of threaded removable fasteners.**

a. ____

b. ____

c. ____

d. ____

Name two shapes of bolts and nuts.

190. ____

191. ____

192. **Select types of locknuts and locking devices by placing an "a" in the appropriate blanks.**

____ a. Fillister head

____ b. Cotter pin

____ c. Set screw

____ d. Fluted socket

____ e. Welding

____ f. Hex slotted nut

193. **Name four types of standard cap screws.**

a. ____

b. ____

c. ____

d. ____

194. **Complete the following list of types of machine screws.**

a. Round head

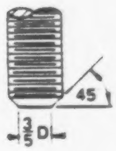
b. ____

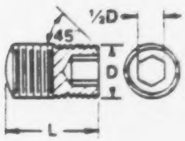
c. Oval head

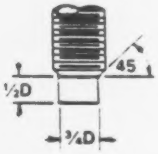
d. Fillister head

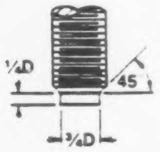
195. **Identify set screw heads and points.**

a. ________ b. ________ c. ________ d. ________

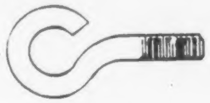


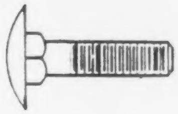




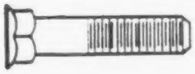


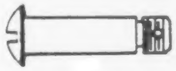
196. **Identify miscellaneous bolts and screws.**



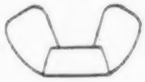


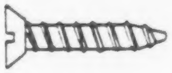
a. ______________________ b. ______________________





c. ______________________ d. ______________________





e. ______________________ f. ______________________

197. **Select devices to lock components on a shaft by placing an "a" in the appropriate blanks.**

____ a. Woodruff key

____ b. Cleavage pin

____ c. Cotter key

____ d. Joggle clamp

198. **Select types of keys to prevent relative motion between wheel and shaft by placing an "a" in the appropriate blanks.**

____ a. Flat

____ b. Square

____ c. Knurled

____ d. Torsion

____ e. Dart-type

____ f. Woodruff

Select true statements concerning washers by placing an "a" in the appropriate blanks. Place a "b" in the appropriate blanks for false statements.

199. ____ Conical washers have spring action

200. ____ Spring washers have built-in pressure

201. ____ Tooth lock washers are used mainly for bearing surface

202. ____ Helical spring washers are locking

Distinguish between types of lock washers by placing an "a" next to the helical spring washers and a "b" next to the tooth lock washers.

203. ____ Plain

204. ____ Dome

205. ____ External

206. ____ Countersunk

207. ____ Nonlink positive

208. ____ Dished

MODULE: INTRODUCTION TO PRODUCTION/MANUFACTURING DRAFTING

UNIT II: INTRODUCTION TO MACHINE DRAWINGS

ANSWERS TO UNIT TEST

Lesson 1

1. c (O 1 and 2)
2. ab (O 1 and 2)
3. bd (O-1)
4. a (O 1 and 2)
5. e (O 1 and 2)
6. bc (O-1)
7. be (O-1)
8. b (O 1 and 2)
9. ce (O-1)
10. ae (O-1)
11. ac (O 1 and 2)
12. ad (O-1)
13. cd (O-1)
14. d (O 1 and 2)
15. b (O 1 and 2)
16. a (O 1 and 2)
17. a (O 1 and 2)
18. b (O 1 and 2)
19. b (O 1 and 2)
20. a (O 1 and 2)

21. Zone for location of change (O 1 & 2)
22. Letter of change (O 1 and 2)
23. Date of change (O 1 and 2)
24. Person checking change (approved by) (O 1 and 2)

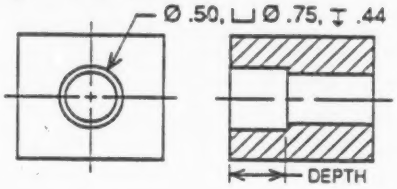
25. (O 1 and 2)
    a. Any two of the following:
        1) Item number referring to assembly drawing
        2) Part name
        3) Number required
        4) Material from which part is made
    b. Any four of the following:
        1) Stock number
        2) Description or nomenclature
        3) Address of vender
        4) Unit of measure
        5) Group subassembly where used
        6) Approval
        7) Release date
        8) Originator
        9) Revision
        10) Stock size
        11) Pattern number
        12) Weight

26. (O-1)
    a. Shape description
    b. Dimensions
    c. Notes
27. c (O-1)
28. e (O 1 and 2)
29. d (O-1)
30. a (O-1)
31. b (O-1)

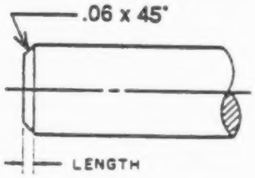
Lesson 2

32. ad (O-1)
33 cd (O-1)
34. bd (O-1)
35. a (O-1)
36. bc (O-1)
37. ce (O-1)
38. d (O-1)
39. be (C-1)
40. e (O-1)
41. b (O-1)
42. ae (O-1)
43. abn (O-1)
44. ac (O-1)
45. c (O-1)
46. cd (O-1)
47. ad (O-1)
48. ab (O-1)
49. bc (O-1)
50. bd (O-1)
51. ce (O-1)
52. b (O-1)
53. a (O-1)
54. d (O-1)
55. ae (O-1)
56. be (O-1)
57. ac (O-1)
58. c (O-1)
59. e (O-1)
60. e (O-1)
61. ab (O-1)
62. bd (O-1)
63. b (O-1)
64. ad (O-1)
65. a (O-1)
66. bc (O-1)
67. d (O-1)
68. ce (O-1)
69. ae (O-1)
70. be (O-1)
71. c (O-1)
72. cd (O-1)
73. ac (O-1)
74. de (O-1)
75. a (O-1)
76. a (O-1)
77. a (O-1)
78. b (O-1)
79. b (O-1)
80. a (O-1)
81. a (O-1)
82. a (O-1)
83. a (O-1)
84. a (O-1)
85. a (O-1)
86. b (O-1)
87. b (O-1)
88. b (O-1)
89. a (O-1)
90. a (O-1)
91. a (O-1)
92. a (O-1)
93. a (O-1)
94. a (O-1)
95. (O-1)
96. (O 1 and 3) a. Taper
    b. Diamond pattern knurl
    c. Neck
    d. Woodruff key
    e. Chamfer
    f. Flat key

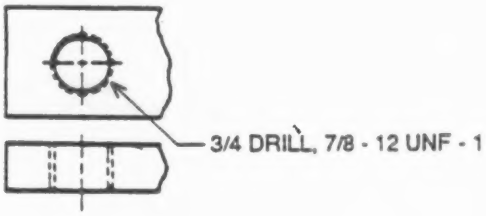
97. (O 1 and 3)



98. (O 1 and 3)

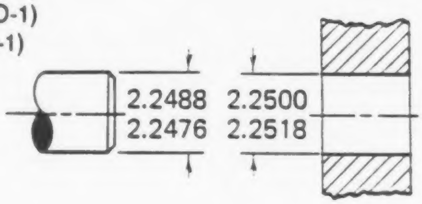


99. (O 1 and 3)

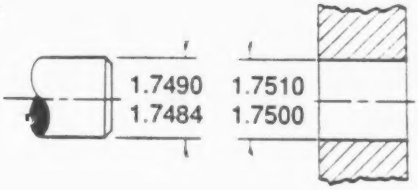


100. (O-1) Evaluated to the satisfaction of the instructor
101. a (O-1)

102. b (O-1)
103. b (O-1)
104. a (O-1)
105. a (O-1)
106. c (O-1)
107. b (O-1)
108. c (O-1)
109. b (O-1)
110. a (O-1)
111. c (O-1)
112. a (O-1)
113. a (O-1)
114. (O-1)



115. (O-1)



Lesson 3

116. ad (O 1 and 3)
117. d (O 1 and 3)
118. cd (O 1 and 3)
119. a (O 1 and 3)
120. ac (O 1 and 3)
121. ae (O 1 and 3)
122. c (O 1 and 3)
123. ce (O 1 and 3)
124. be (O 1 and 3)
125. e (O 1 and 3)
126. bd (O 1 and 3)
127. ab (O 1 and 3)
128. b (O 1 and 3)
129. bc (O 1 and 3)
130. de (O 1 and 3)
131. b (O 1 and 3)
132. ab (O 1 and 3)
133. de (O 1 and 3)
134. bc (O 1 and 3)
135. d (O 1 and 3)
136. a (O 1 and 3)
137. e (O 1 and 3)
138. ac (O 1 and 3)
139. cd (O 1 and 3)
140. bd (O 1 and 3)
141. ae (O 1 and 3)
142. ce (O 1 and 3)
143. ad (O 1 and 3)
144. c (O 1 and 3)
145. Removable (O 1 and 3)
146. Permanent (O 1 and 3)
147. Holding parts together (O 1 and 3)
148. Adjustment (O 1 and 3)
149. Power transmission (O 1 and 3)
150. Depth (O 1 and 3)
151. Crest (O 1 and 3)
152. Root (O 1 and 3)
153. Side (O 1 and 3)
154. Minor diameter (O 1 and 3)
155. Pitch diameter (O 1 and 3)
156. Major diameter (O 1 and 3)
157. Pitch (O 1 and 3)
158. Thread angle (O 1 and 3)
159. Sharp V (O 1 and 3)
160. American National (O 1 and 3)
161. Unified (O 1 and 3)
162. Square (O 1 and 3)
163. Acme (O 1 and 3)
164. Whitworth Standard (O 1 and 3)
165. Metric (O 1 and 3)
166. Knuckle (O 1 and 3)
167. Buttress (O 1 and 3)
168. L = 1/10 (O 1 and 3)
169. L = 2/18 = 1/9 (O 1 and 3)
170. L = 3/24 = 1/8 (O 1 and 3)
171. Detailed (O 1 and 3)
172. Schematic (O 1 and 3)
173. Simplified (O 1 and 3)
174. b (O 1 and 3)
175. c (O 1 and 3)
176. a (O 1 and 3)
177. Major diameter (O 1 and 3)
178. Threads per inch (O 1 and 3)
179. Class of fit (O 1 and 3)
180. Left hand (O 1 and 3)
181. Thread depth (O 1 and 3)
182. Metric (O 1 and 3)
183. Major diameter in mm (O 1 and 3)
184. Pitch in mm (O 1 and 3)
185. Class of fit (O 1 and 3)
186. Internal thread (O 1 and 3)
187. b (O 1 and 3)
188. a (O 1 and 3)
189. Any four of the following: (O 1 and 3)
    a. Bolts
    b. Studs
    c. Cap screws
    d. Machine screws
    e. Set screws
190. Hexagon head (O 1 and 3)
191. Square head (O 1 and 3)
192. b, c, f (O 1 and 3)
193. Any four of the following: (O 1 and 3)
    a. Hexagon head
    b. Flat head
    c. Round head
    d. Fillister head
    e. Hex socket head
194. b. Flat head (O 1 and 3)
195. (O 1 and 3)
    a. Flat point
    b. Hex socket head
    c. Full dog point
    d. Half dog point
196. (O 1 and 3)
    a. Eye bolt
    b. Step bolt
    c. Square neck bolt
    d. Clevis
    e. Wing nut
    f. Tapping screw
197. a, c (O 1 and 3)
198. a, b, f (O 1 and 3)
199. a (O 1 and 3)
200. a (O 1 and 3)
201. b (O 1 and 3)

202. a (O 1 and 3)
203. a (O 1 and 3)
204. b (O 1 and 3)
205. b (O 1 and 3)
206. b (O 1 and 3)
207. a (O 1 and 3)
208. b (O 1 and 3)

MODULE: INTRODUCTION TO PRODUCTION/MANUFACTURING DRAFTING

UNIT III: INTRODUCTION TO SHEET METAL DRAWINGS

UNIT OBJECTIVE

After completion of this unit, the student should be able to match terms related to sheet metal developments to correct definitions, select true statements concerning important characteristics of rotation, list methods for finding intersections of surfaces and name three general groups of developments. The student will also be able to construct true lengths by rotation, construct intersections of surfaces, construct intersections of surfaces using two-view method, construct radial line and parallel line developments, and construct special developments using triangulation. This knowledge will be evidenced by correctly performing the procedures outlined in the assignment sheets and by scoring ____ percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

3.1 Match terms related to sheet metal developments with the correct definitions.

3.2 Select true statements concerning important characteristics of rotation.

3.3 List methods for finding intersections of surfaces.

3.4 Name three general groups of developments.

3.5 Demonstrate the ability to:

- a. Construct true lengths of lines by rotation. (AS 3.1)
- b. Construct intersections of surfaces. (AS 3.2)
- c. Construct intersections of surfaces using two-view method. (AS 3.3)
- d. Construct radial line developments. (AS 3.4)
- e. Construct parallel line developments. (AS 3.5)
- f. Construct special developments using triangulation. (AS 3.6)

MODULE: INTRODUCTION TO PRODUCTION/MANUFACTURING DRAFTING

UNIT III: INTRODUCTION TO SHEET METAL DRAWINGS

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the instructor

D. Lesson plan

- 1. **Lesson 1: Sheet Metal Developments** 209
    - a. Information outline
    - b. Transparency masters

      TM 3.1: Rotation of a Point
      TM 3.2: True Lengths by Rotation
      TM 3.3: True Sizes by Rotation
      TM 3.4: Intersections with Edge View Given
      TM 3.5: Intersections Using Auxiliary Views
      TM 3.6: Intersections of Cylinders
      TM 3.7: Developments
      TM 3.8: Radial Line Developments--Pyramids
      TM 3.9: Radial Line Developments--Cones
      TM 3.10: Parallel Line Developments--Prisms
      TM 3.11: Parallel Line Developments--Cylinders
      TM 3.12: Triangulation

    - c. Assignment sheets

      AS 3.1: Construct True Lengths of Lines by Rotation
      AS 3.2: Construct Intersections of Surfaces
      AS 3.3: Construct Intersections of Surfaces Using Two-view Method
      AS 3.4: Construct Radial Line Developments
      AS 3.5: Construct Parallel Line Developments
      AS 3.6: Construct Special Developments Using Triangulation

    - d. Answers to assignment sheets

E. Unit test

F. Answers to unit test

REFERENCES

A. Earle, James H. Descriptive Geometry. 2nd ed. Reading, MA: Addison-Wesley Publishing Co., 1978.

B. Giesecke, Frederick E., et. al. Technical Drawing. New York, NY: Macmillan Publishing Co., Inc., 1980.

C. Pare, E.G., Loving, R.O., and Hill, I.L. Descriptive Geometry Metric. 5th ed. New York, NY: Macmillan Publishing Co., Inc., 1977.

D. Slaby, Steve M. Fundamentals of Three Dimensional Descriptive Geometry. 2nd ed. New York, NY: John Wiley and Sons, Inc., 1976.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. Tour a sheet metal fabrication plant.
2. If possible, have students construct models from sheet metal or cardboard.

NOTE: Used aluminum plates from the local newspaper could be a source of metal. Caution the student that sheet metal can cut hands very easily.

MODULE: INTRODUCTION TO PRODUCTION/MANUFACTURING DRAFTING

UNIT III: INTRODUCTION TO SHEET METAL DRAWINGS

LESSON 1: SHEET METAL DEVELOPMENTS

I. Terms and definitions

A. **Bend allowance (BA)**--an additional amount of material necessary when making a bend **NOTE: Usually BA is calculated for material over .65 mm.**

B. **Conic section**--the intersection of a circular cone and a plane

C. **Development**--a pattern of the true sizes of unfolded or unrolled surfaces arranged to be folded to the desired shape

D. **Double curved surface**--a surface which has no straight line elements and cannot be developed

Examples: Sphere, cone, paraboloid, hyperboloid, approximation developments are possible

E. **Elements of a surface**--ruled lines on the surface of geometric shapes

F. **Folding line**--a reference line normally between two views representing the edge of a plane of projection

G. **Master layouts**--original and complete developments of parts used for reference and checking

H. **Parallel line development**--the development of objects that can be developed due to parallel elements on these surfaces

Examples: Cylinders, prisms

I. **Radial line development**--the development of objects that can be developed due to elements radiating from a single point or vertex

Examples: Cones, pyramids

J. **Ruled surface**--any surface generated by straight lines

NOTE: This may be a plane, single curved surface, or a warped surface.

K. **Single curved surface**--a ruled surface generated by a straight line that can be developed

L. **Stretch out line**--a line that is perpendicular to each element on which a parallel line development is unrolled or unfolded

M. **Transition piece**--a piece that connects two differently shaped conductors

N. **Triangulation**--a method of developing surfaces not possible by the parallel line or radial line methods

Examples: Transition pieces, hoppers

O. **True size of a surface**--the exact measurable view of the exact size of a surface found by observation, projection, or calculation

P. **True length diagram**--a diagram of the true lengths projected from the normal views

Q. **True length of a line**--the exact measurable view of the exact length of a line found by observation, projection, or calculation

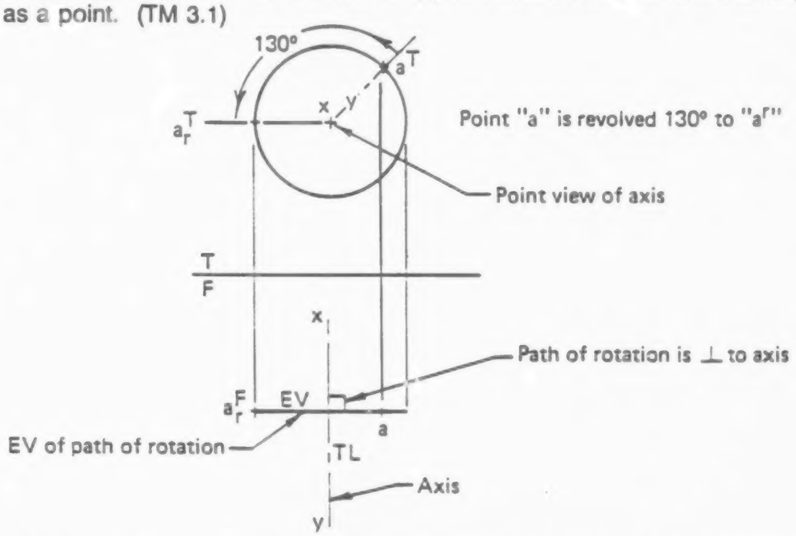
R. **Warped surface**--a ruled surface that cannot be developed

Examples: Oblique helicoid, cylindroid, many exterior surfaces on an airplane, approximation developments are possible

II. Rotation characteristics

NOTE: Rotation is an easier way to fine TL and TS.

A. The path of rotation of any point not on the axis appears as a circle in a view showing the axis of rotation as a point. (TM 3.1)

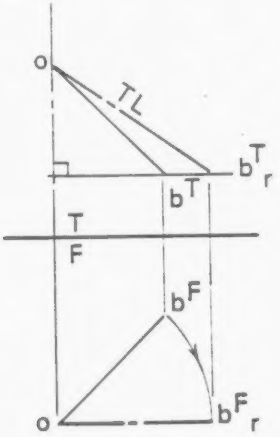


B. The plane of the path of rotation of any point appears in edge view (EV) and perpendicular to the axis in a view showing the axis of rotation in true length.

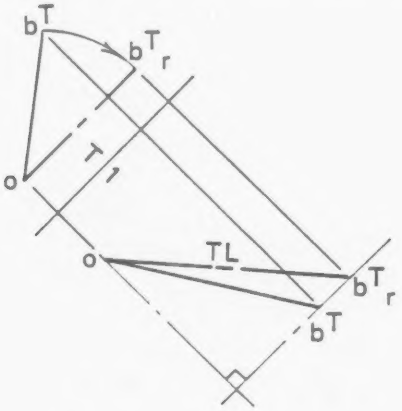
C. True lengths by rotation (TM 3.2)

1. A line may be rotated until it is parallel to a principal plane.

2. The line is projected onto the adjacent plane.

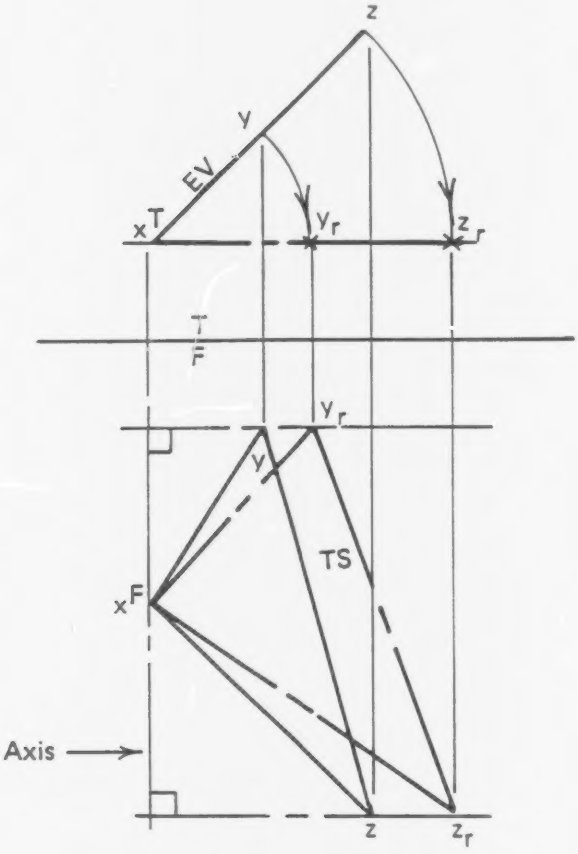


3. Since it is parallel to the folding line, it is in true length in the adjacent plane.



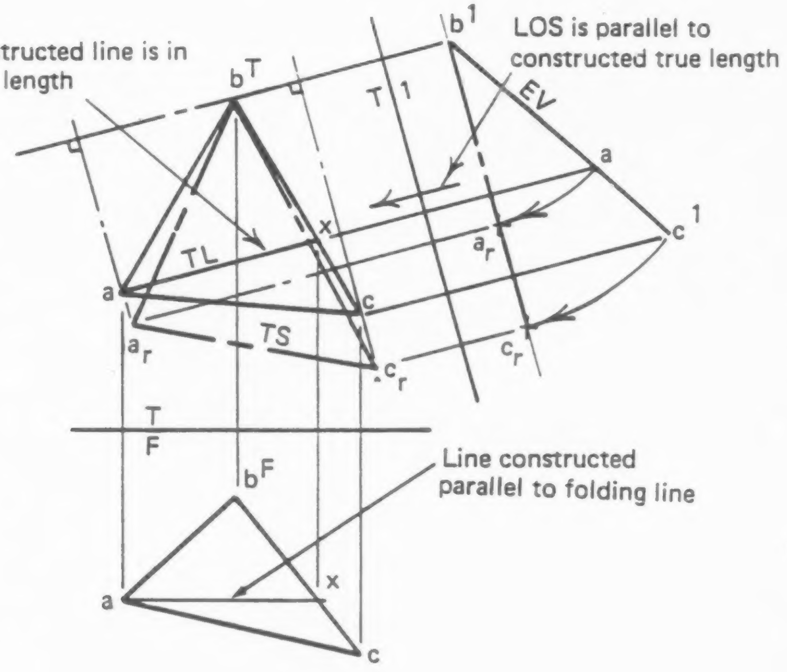
D. True sizes by rotation (TM 3.3)

1. An edge view may be rotated until it is parallel to an orthographic plane.



2. The edge view is then projected onto the plane and is in true size.

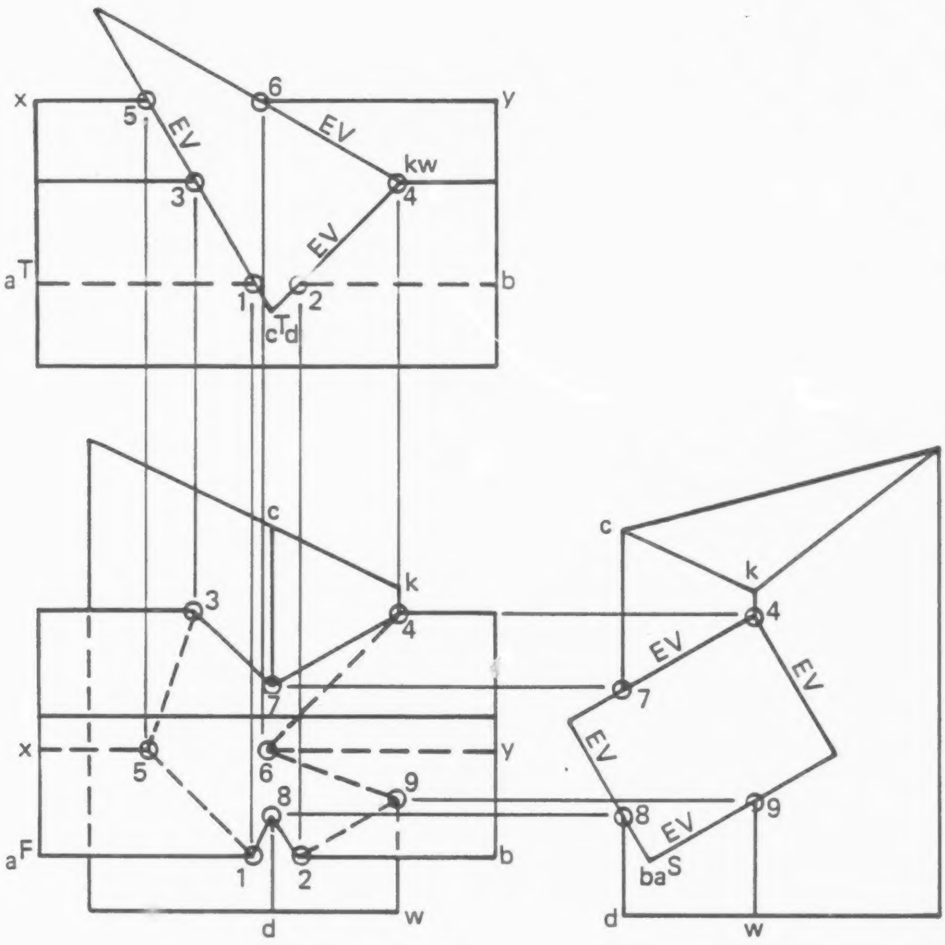
NOTE: In this example, edge view is found by constructing horizontal line ax in front view and projecting TL line in top view.


Constructed line is in true length
b T
b 1
LOS is parallel to constructed true length
T
1
EV
a
c 1
x
TL
a r
a
c
a r
TS
c r
c r
T
F
b F
Line constructed parallel to folding line
a
x
c

III. Methods for finding intersections of surfaces

A. Edge view given (TM 3.4)

Example:



1. When edge views are given, existing piercing points can be readily located and projected.

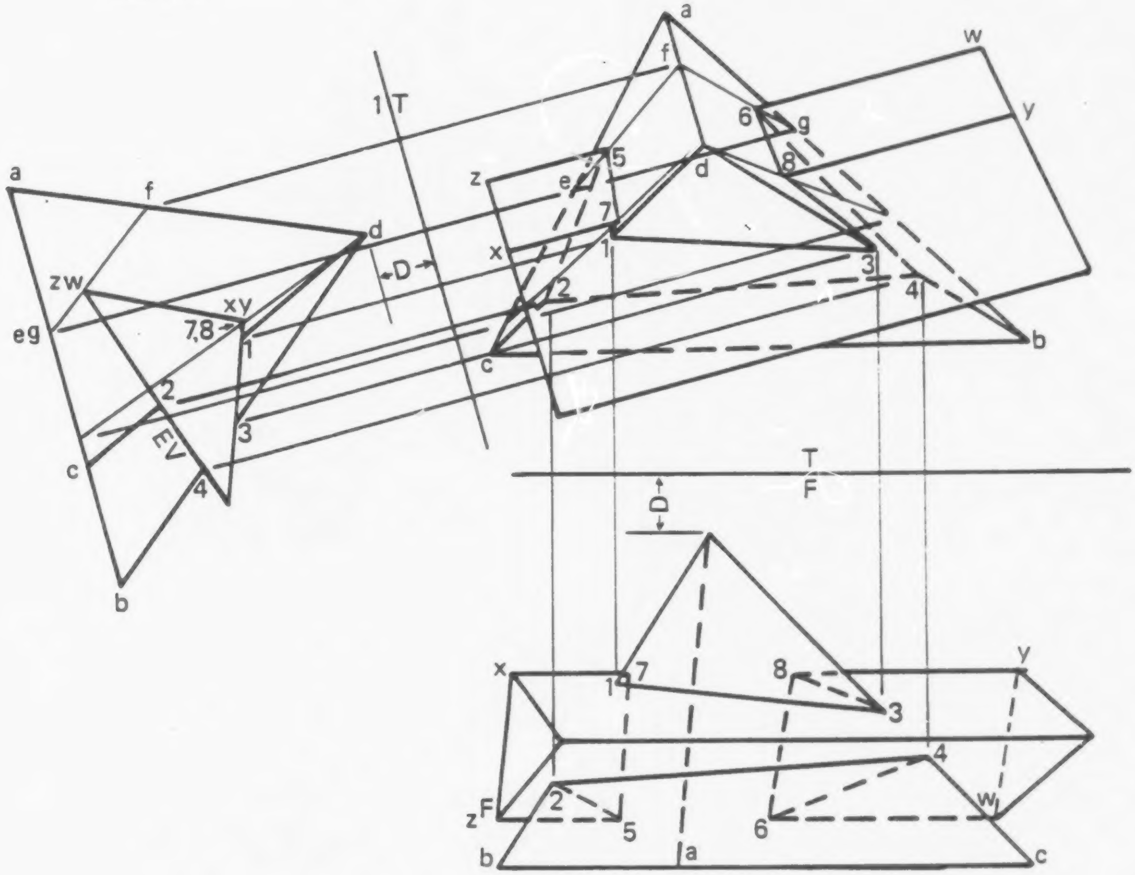
2. Visibility requires logical thinking of the position of the line of sight and what is near the observer and what is far from the observer.

3. Points 5 and 6 can be observed in top view where line xy intersects the two edge views.

4. Points 8 and 9 can be observed in the side view where the edges of the planes are intersected by cd and kw.

B. Auxiliary view method (TM 3.5)

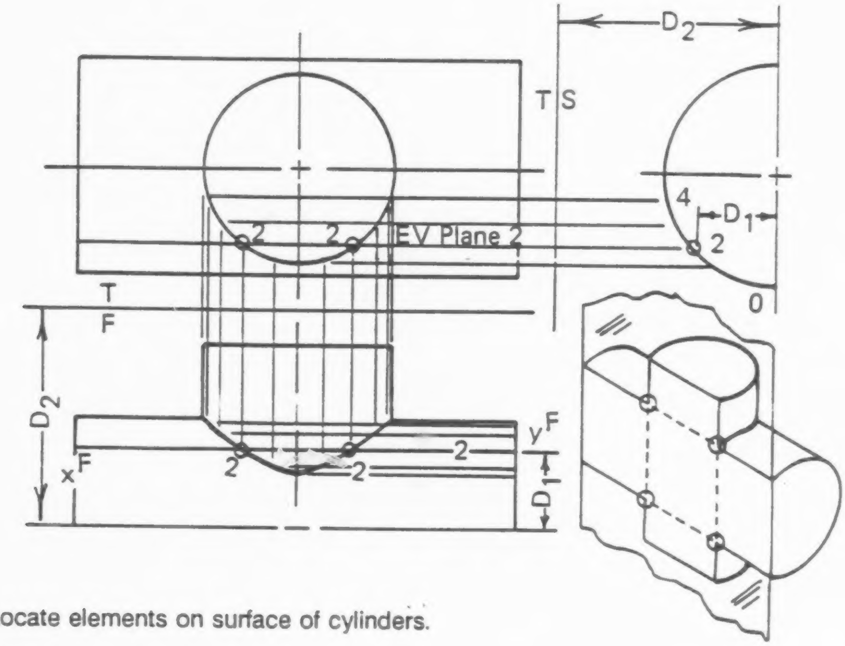
Example:



1. Construct an auxiliary view to give edges of surfaces.
    a. Line zw is in TL in top view.
    b. LOS is parallel to TL to give edge views of the planes in the auxiliary view.
2. When edges are constructed, piercing points may be readily located and projected.

    NOTE: The two-view method can be used to find additional piercing points.
3. The two-view method of piercing points is used to find where line zw and line xy intersect the planes adc and adb.
4. Visibility requires logical thinking of the position of the line of sight and what is near the observer and what is far from the observer.

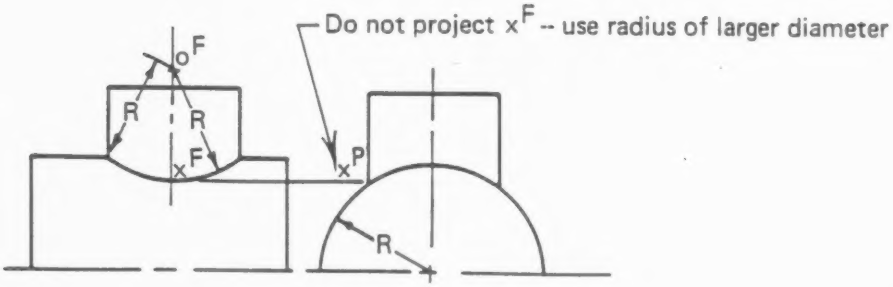
C. Cylinders intersecting (TM 3.6)



1. Locate elements on surface of cylinders.
2. Find their intersection.
3. Use correct visibility.

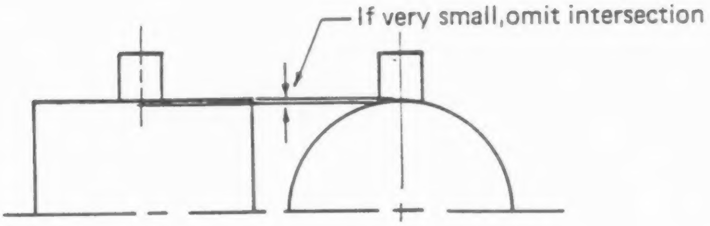
D. Approximate intersections

1. Large diameters--use radius of larger cylinder



Do not project x^F -- use radius of larger diameter

2. Small diameters--ignore intersection



IV. General groups of developments (TM 3.7)

   A. Radial line (TMs 3.8 and 3.9)

      Example: Cone, pyramids

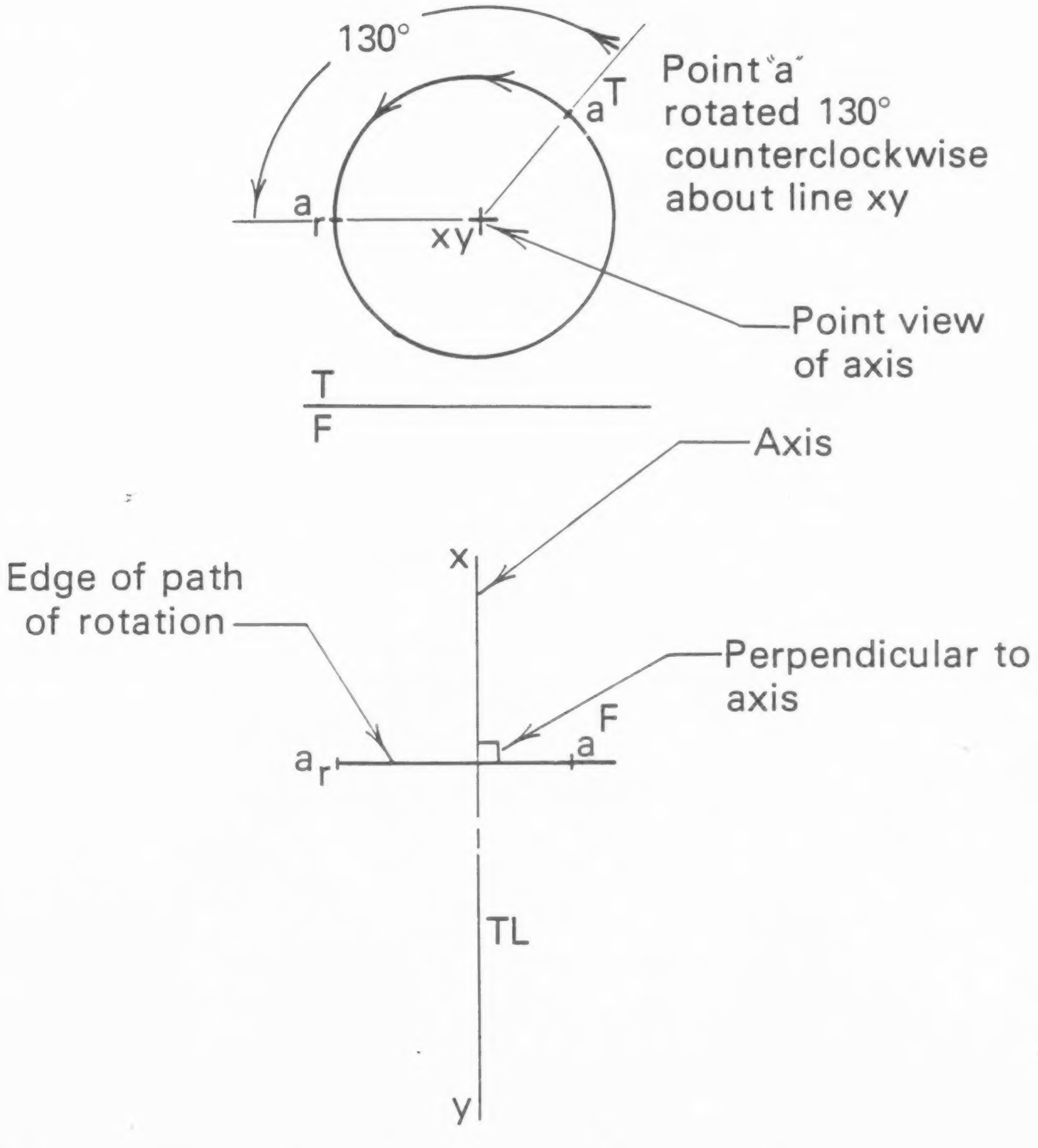
   B. Parallel line (TMs 3.10 and 3.11)

      Example: Cylinders, prisms

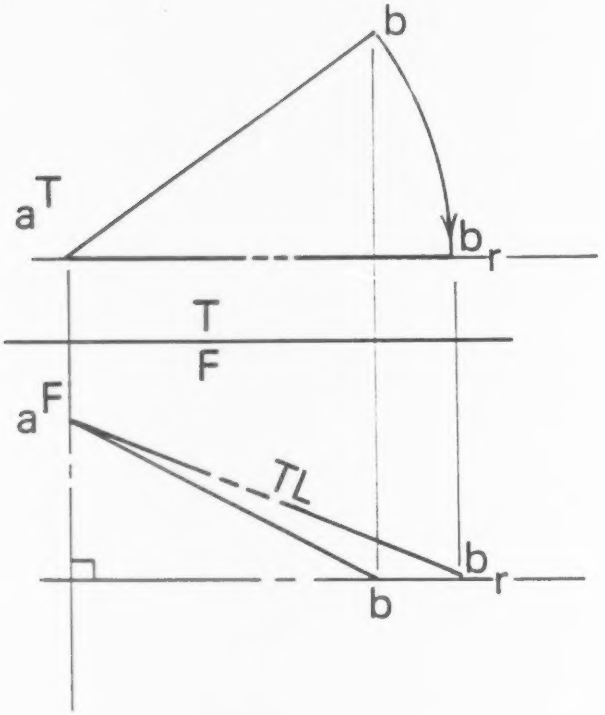
   C. Triangulation (TM 3.12)

      Example: Transition pieces, hoppers

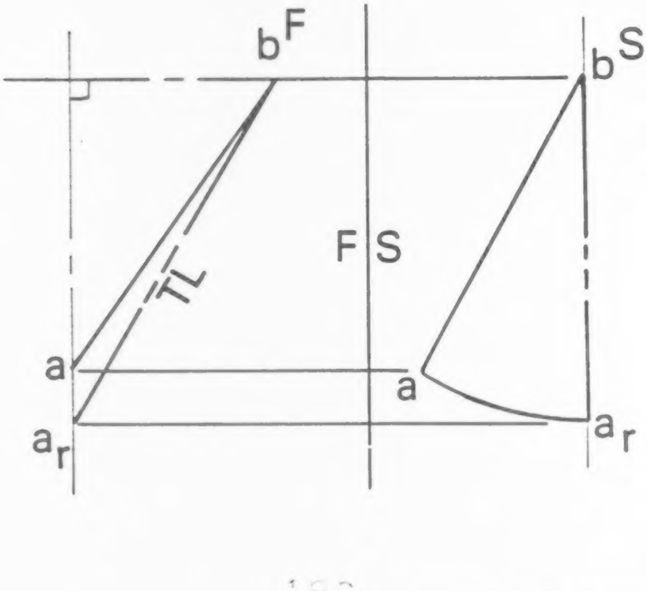
ROTATION OF A POINT



TRUE LENGTHS BY ROTATION

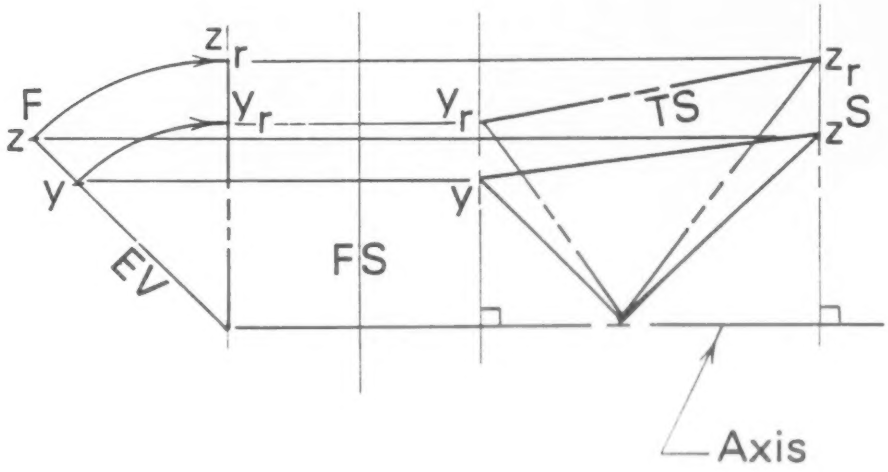


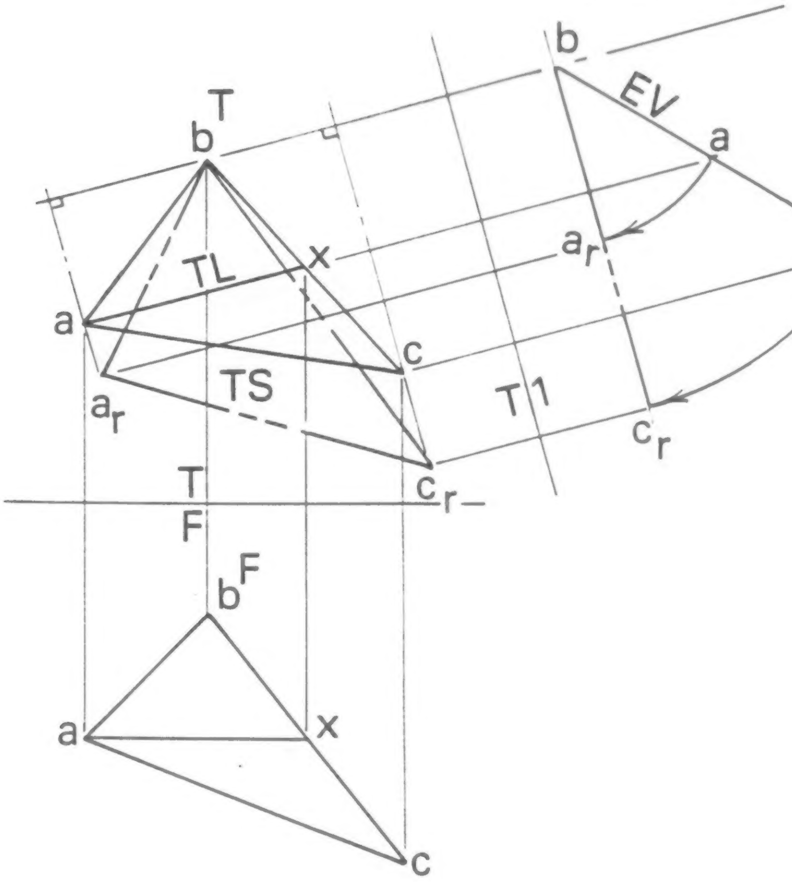
(a)



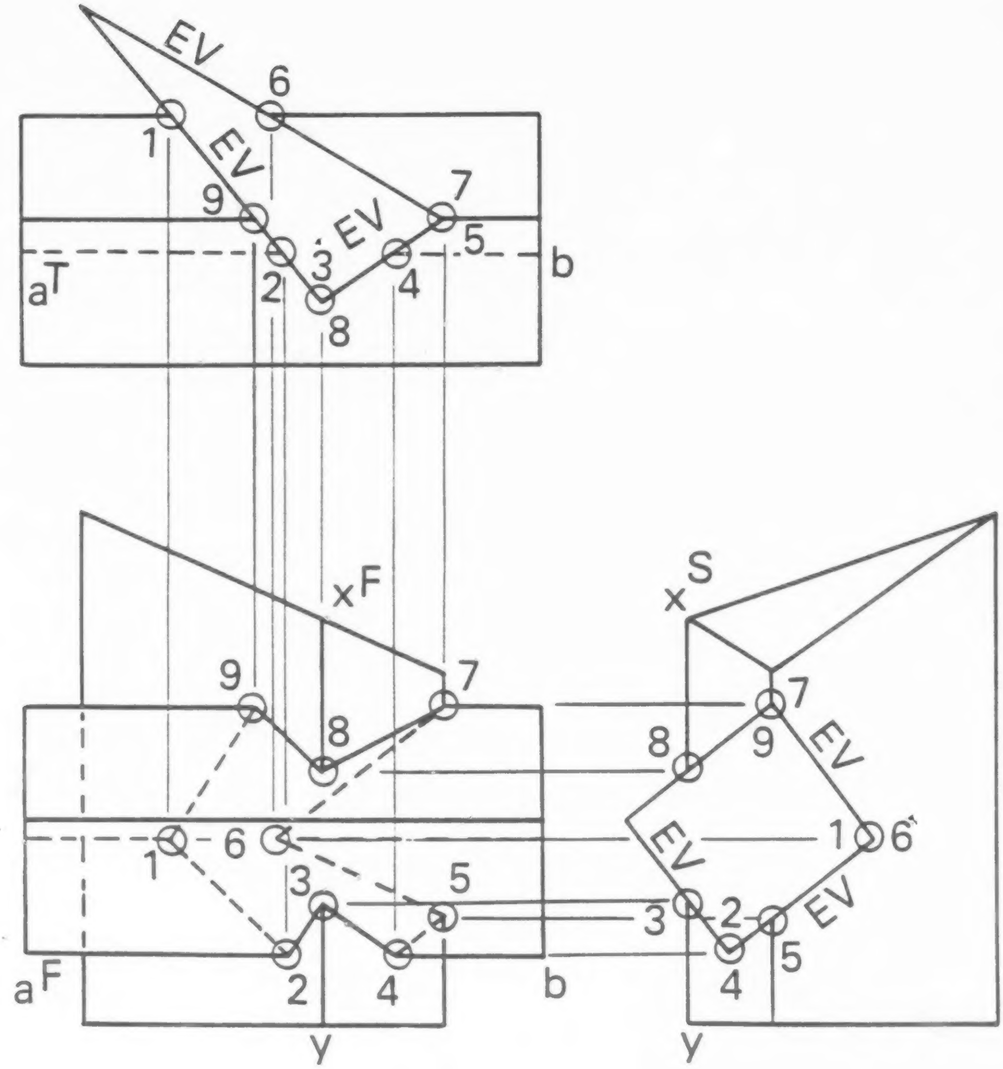
(b)

TRUE SIZES BY ROTATION

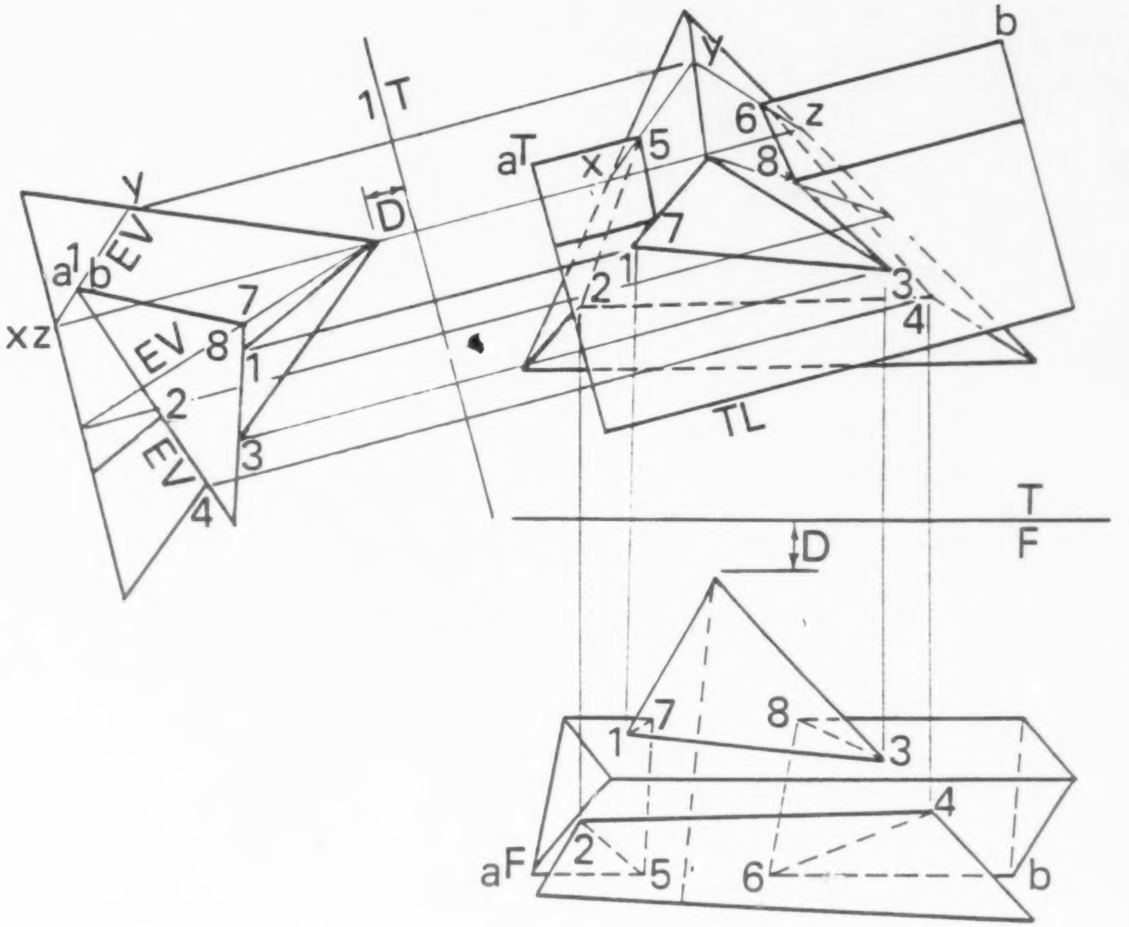




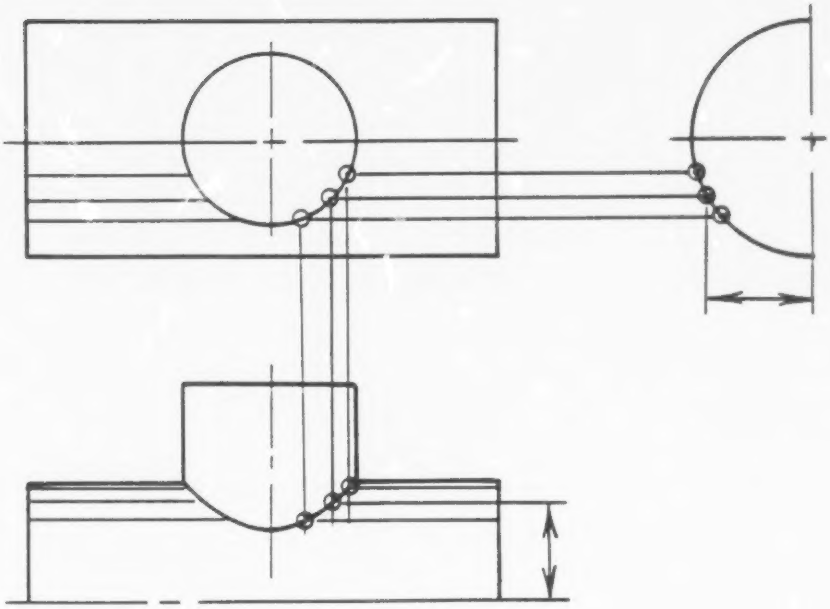
INTERSECTIONS WITH EDGE VIEW GIVEN



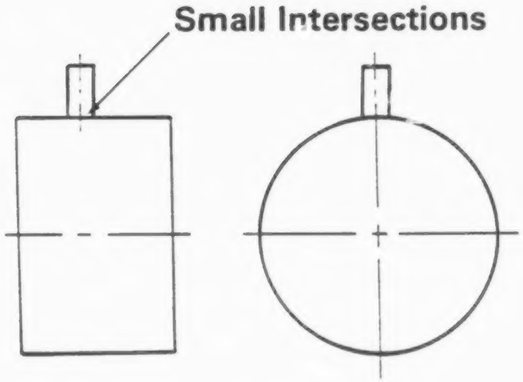
INTERSECTIONS USING AUXILIARY VIEWS



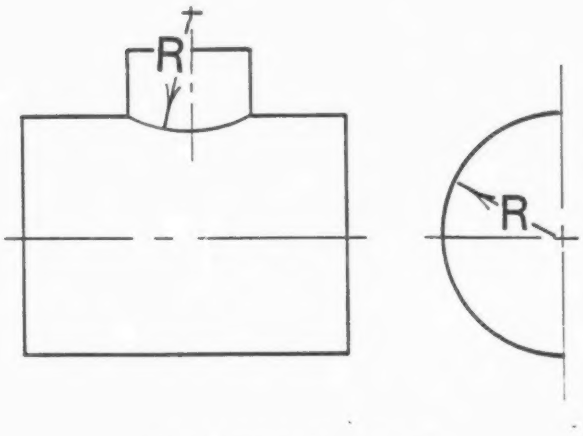
INTERSECTIONS OF CYLINDERS



Projection

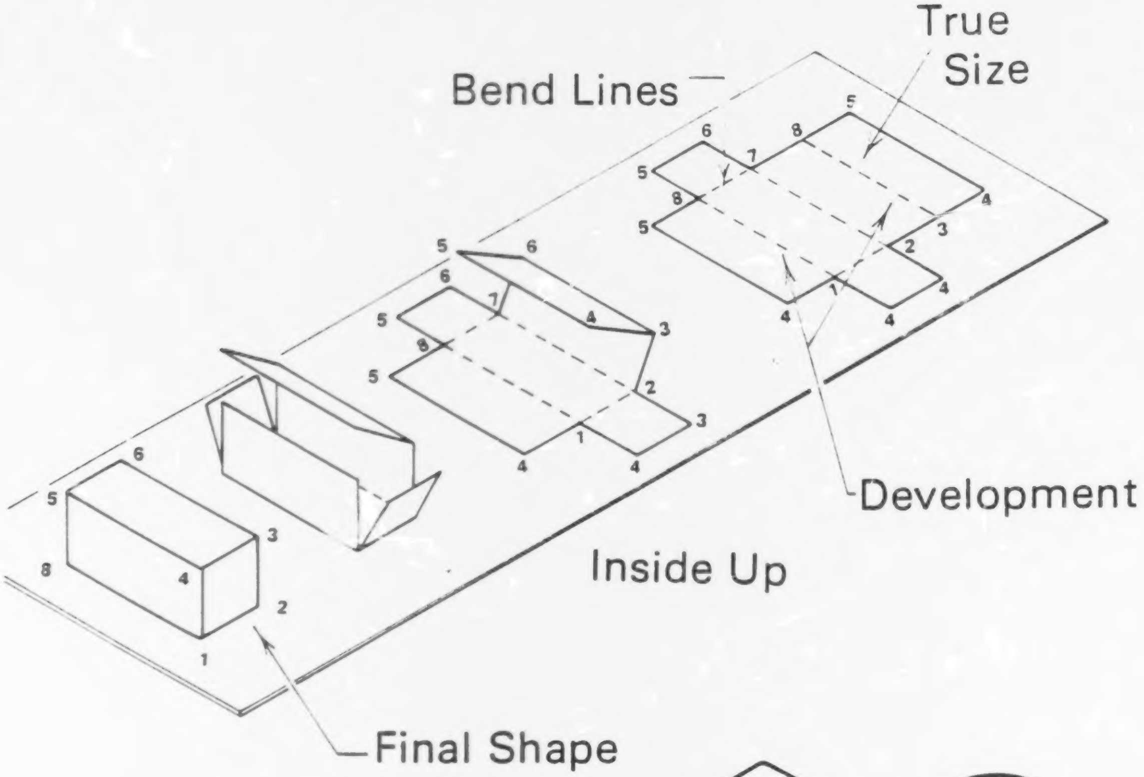


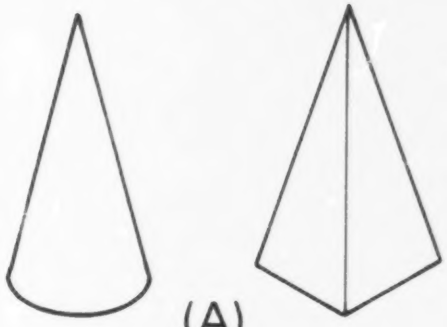
Ignore



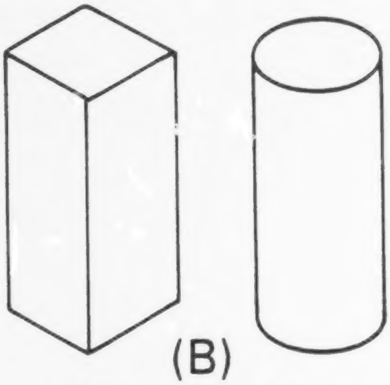
Approximate

DEVELOPMENTS

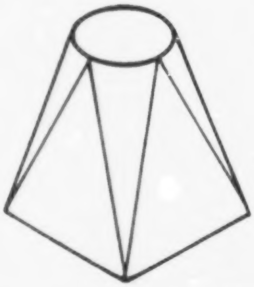




(A)
Radial Line

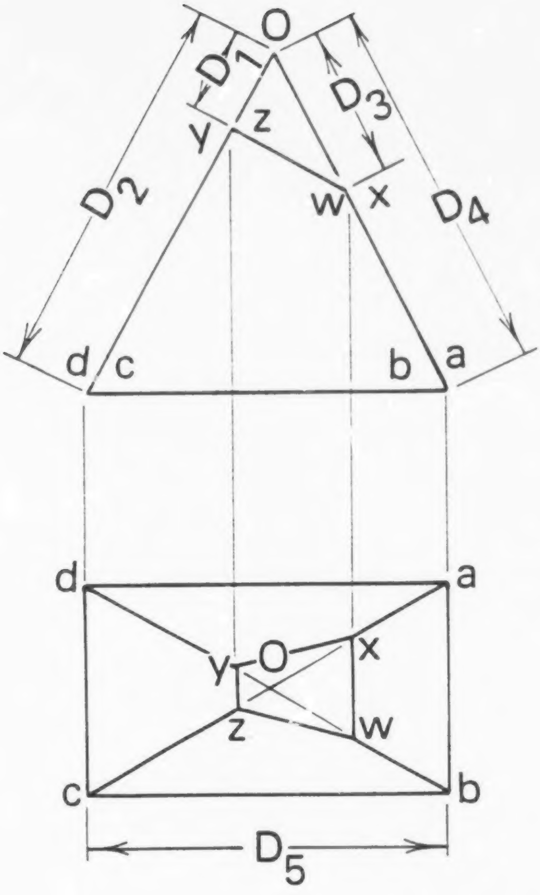


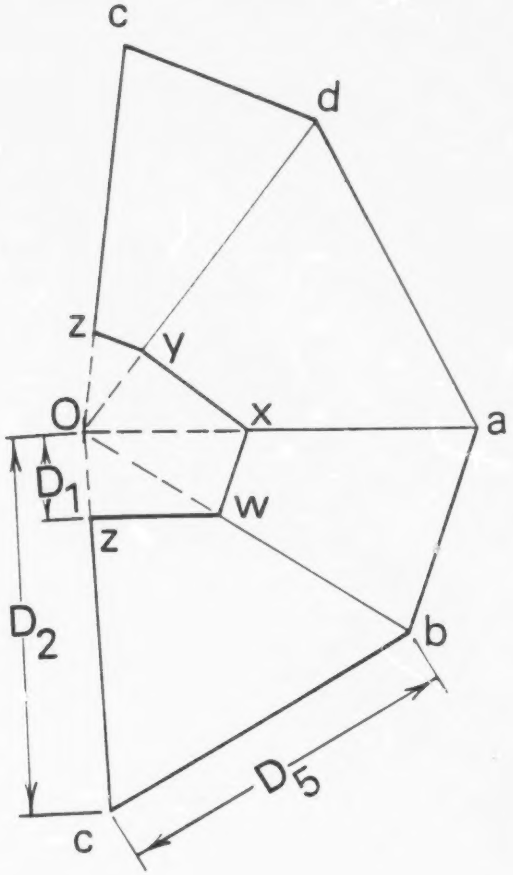
(B)
Parallel Line



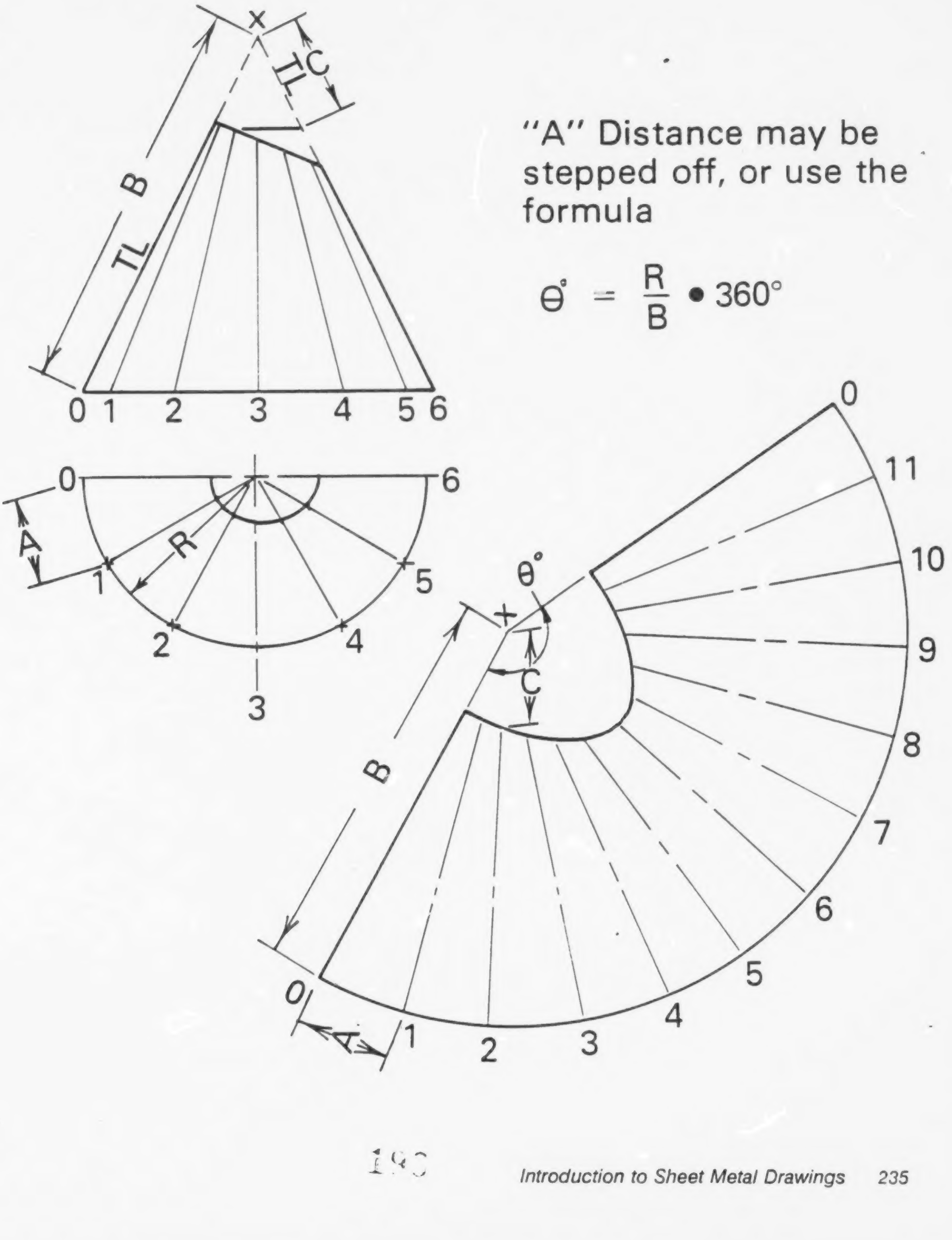
(C)
Triangulation

RADIAL LINE DEVELOPMENTS--PYRAMIDS





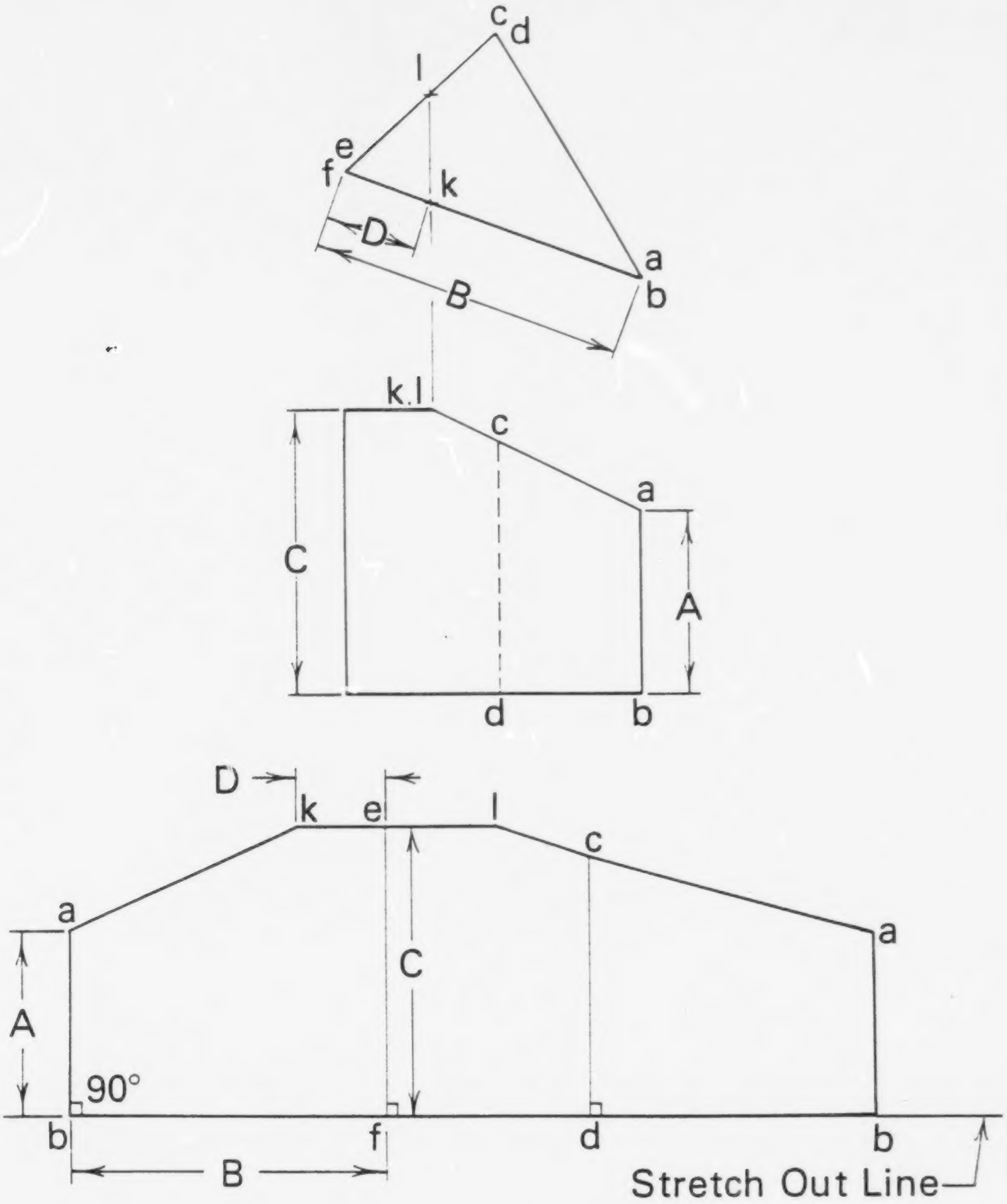
RADIAL LINE DEVELOPMENTS--CONES



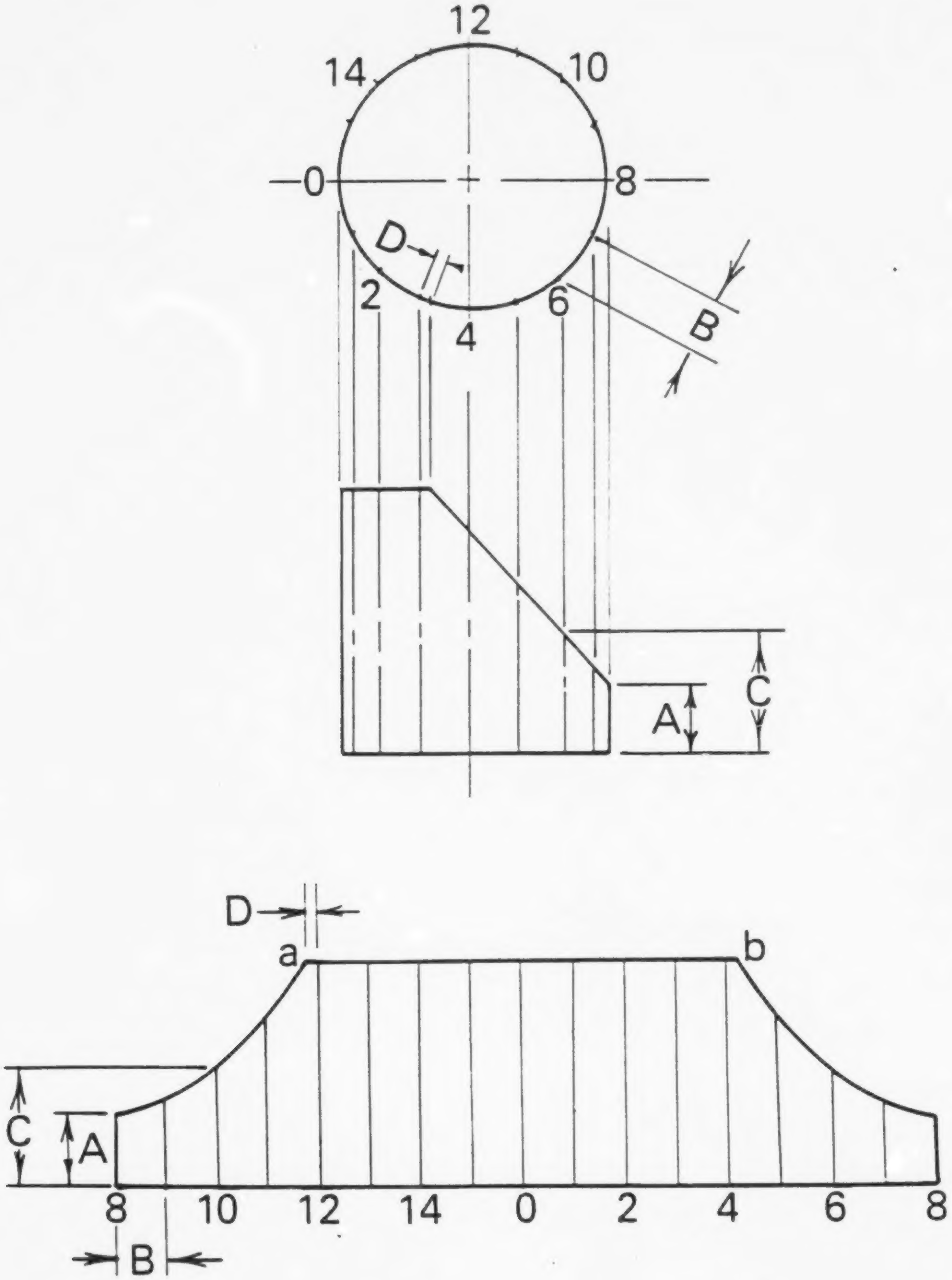
"A" Distance may be stepped off, or use the formula

$$\theta^{\circ} = \frac{R}{B} \bullet 360^{\circ}$$

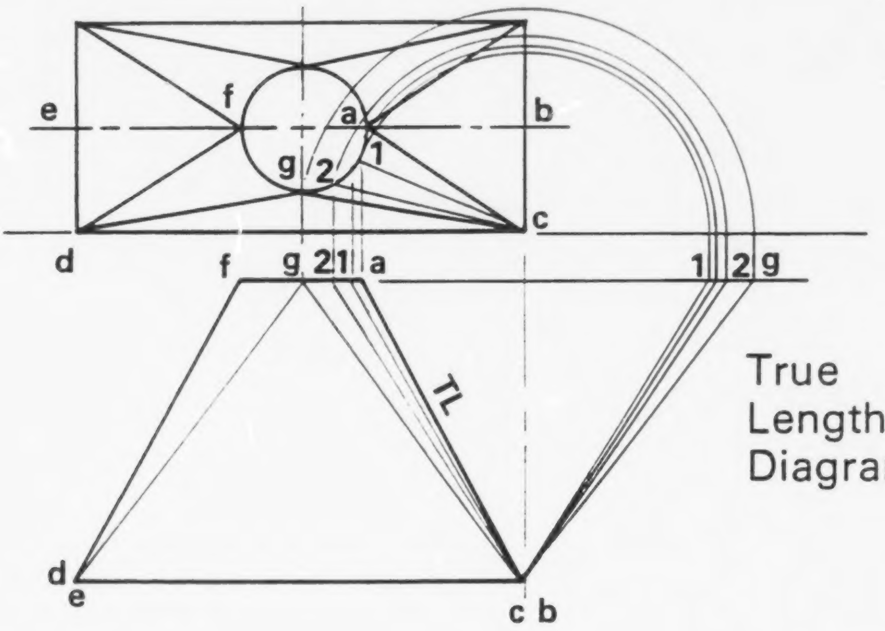
PARALLEL LINE DEVELOPMENTS--PRISMS



PARALLEL LINE DEVELOPMENTS--CYLINDERS

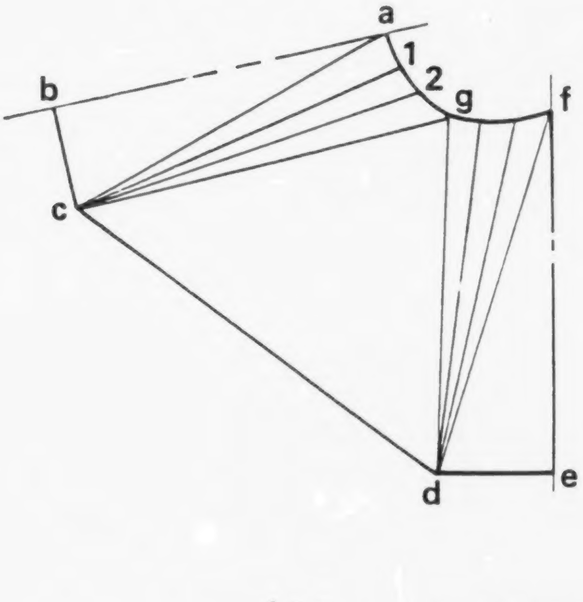


TRIANGULATION



True Length Diagram

Half Development



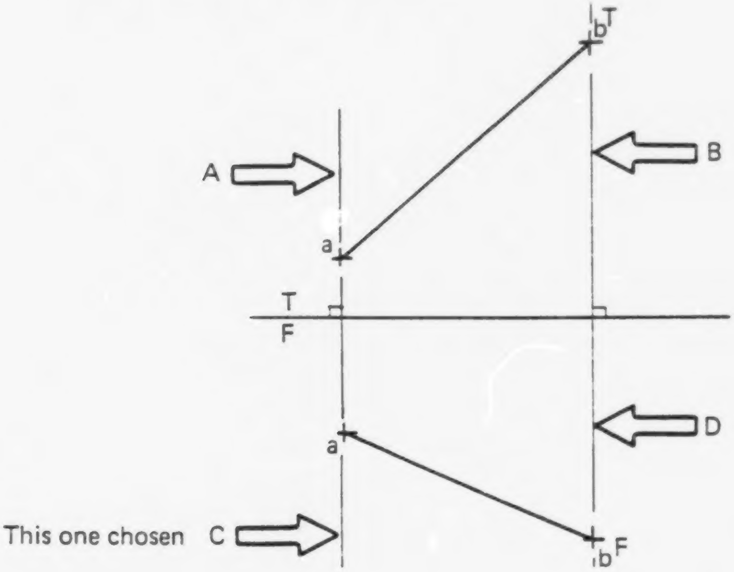
CONSTRUCT TRUE LENGTHS OF LINES BY ROTATION

Introduction: In your previous study of orthographic projection and auxiliary views, the related principal views of an object are found by changing the position of the observer. This is the same as saying change the position of the line of sight. Different views of an object can also be obtained by rotating the object while the observer (LOS) stays stationary. This is the same as a fixed viewing direction (see transparency 3.2). Rotation eliminates some of the auxiliary views previously needed. Rotation also adds the problem of confusion from overlapping views. This confusion can be reduced by using different colored pencils, by using overlays, or as in the case of developments, by using length diagrams.

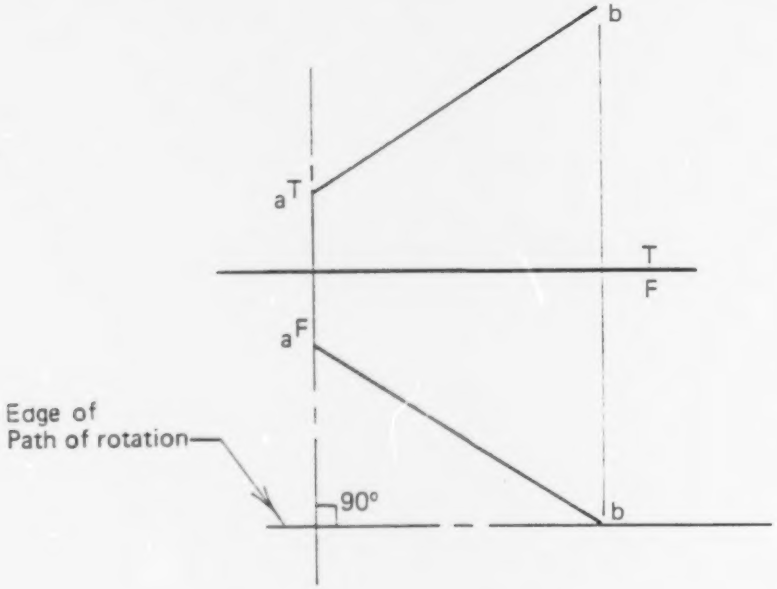
Directions: Construct true lengths of lines by rotation as outlined in the procedure of the following example.

Example:

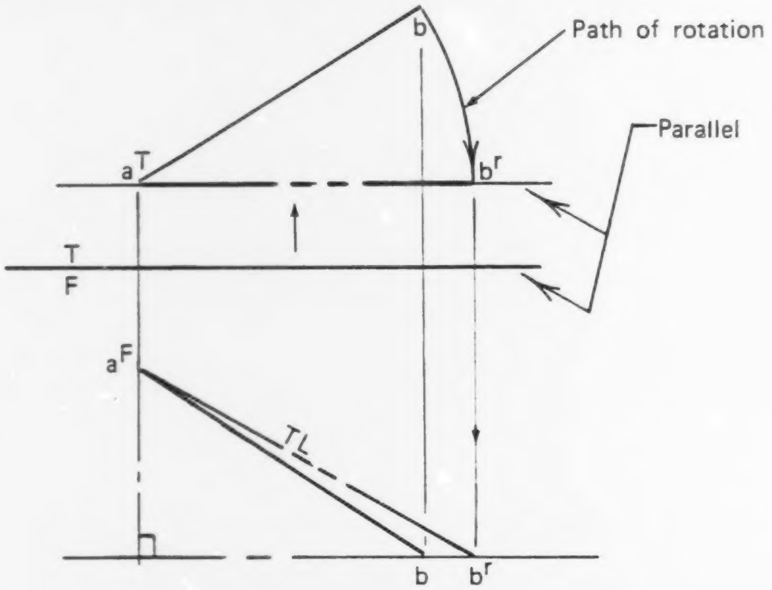
1. Select axis of rotation.
   a. Any one of the following could be chosen: A, B, C, or D; it must be perpendicular to the folding line.
   b. Your choice depends on what view you want TL in and what point you want rotated.
   c. In this example, axis "C" was chosen so TL will be in front view.



2. Construct path of rotation perpendicular to axis through the point to be rotated.



3. In the adjacent view, construct a path of rotation from "b" to a position where "ab" will be parallel to the folding line; mark new point b^r and project to adjacent view.



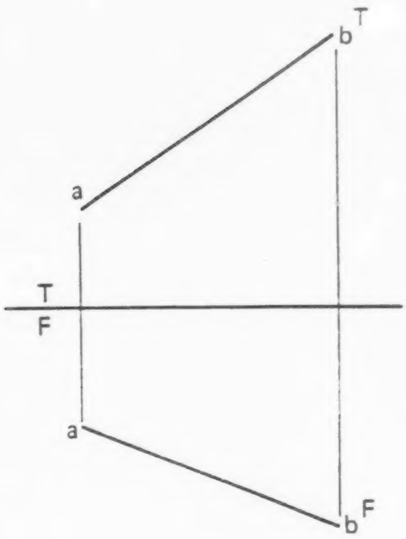
4. Connect "a" to the new b^r in the front view; mark it TL.

NOTE: Line ab^r is in TL because it has been rotated parallel to the front plane or perpendicular to the LOS.

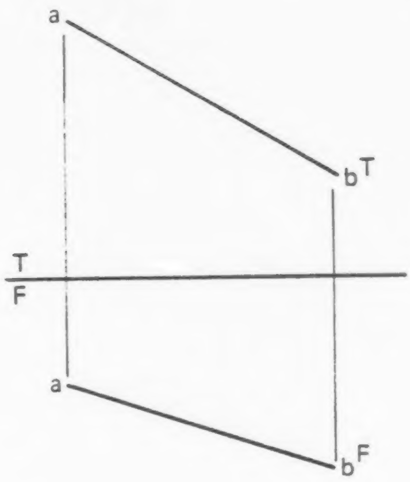
2

Problems.

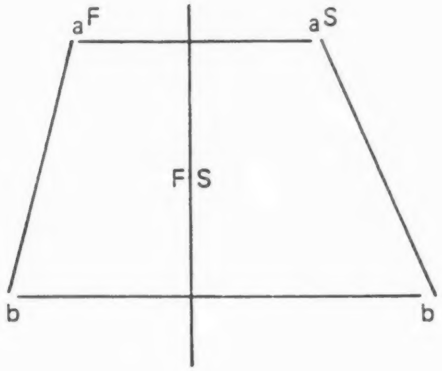
A. Find TL in front view.



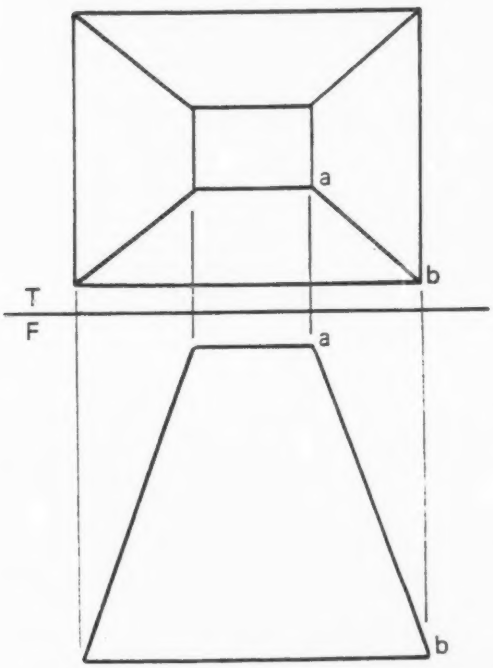
B. Find TL in top view.



C. Find TL in side view.



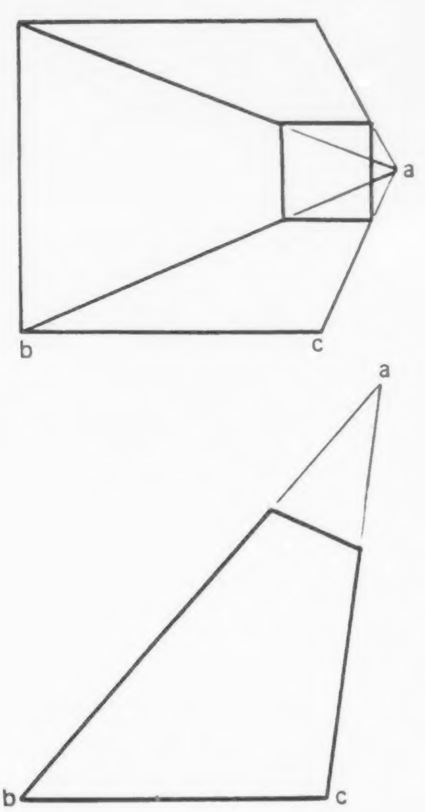
D. Find TL in front view.



E. Find TL of ab and ac.

TL of ab = ________________

TL of ac = ________________

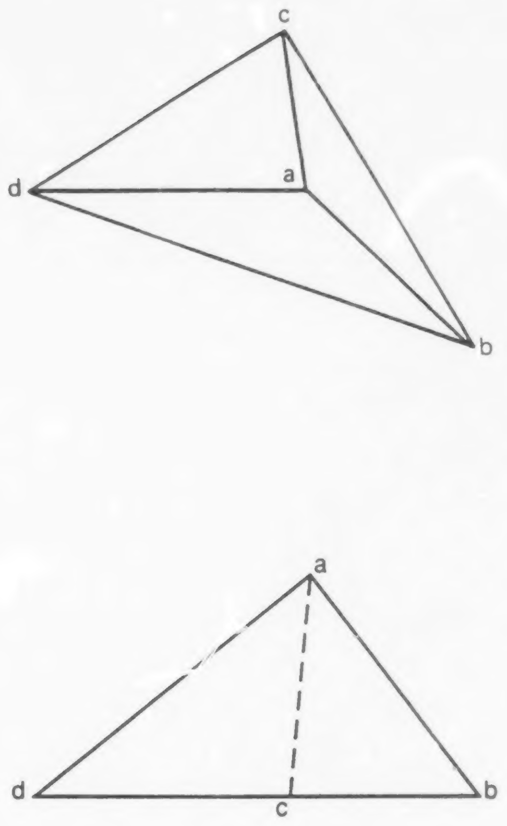


F. Find TL of ab, ac, and ad.

TL of ab = ________________

TL of ac = ________________

TL of ad = ________________



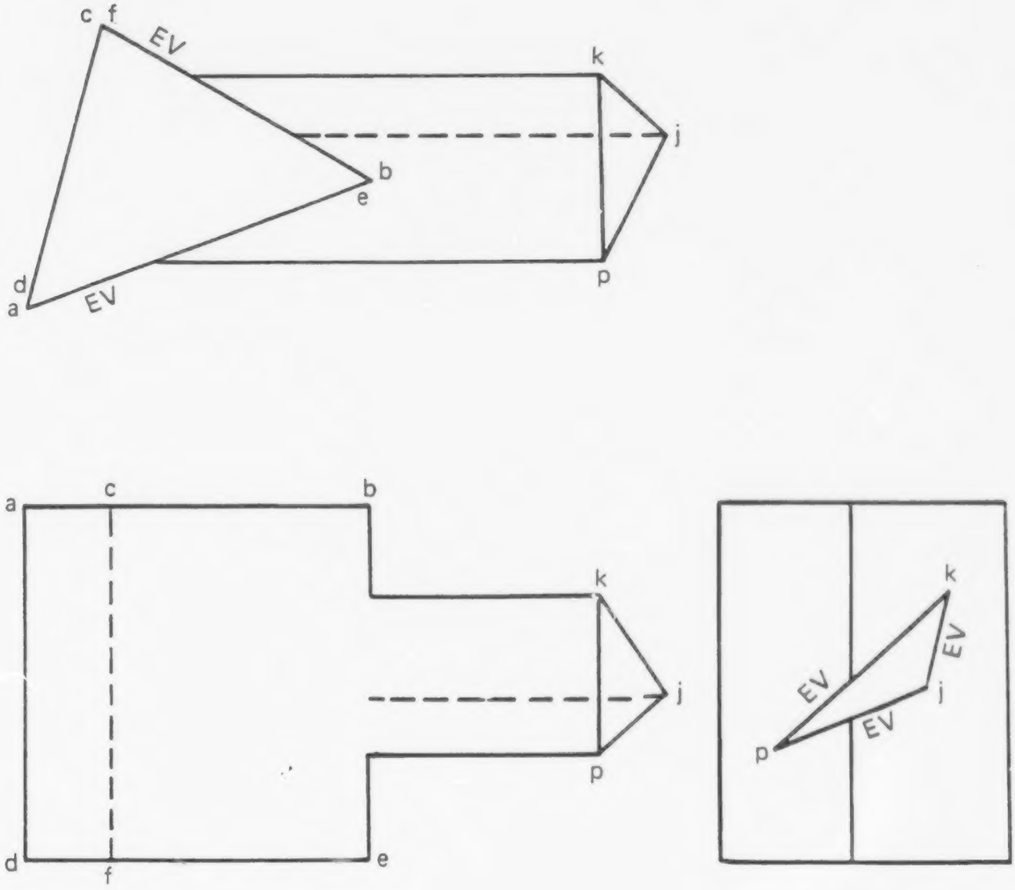
CONSTRUCT INTERSECTIONS OF SURFACES

Directions: Construct intersections of surfaces using edge views. The procedure in the following example is to be used as a guideline for solving the problems.

Example:

1. Identify and label all edge views (EV) and label all points

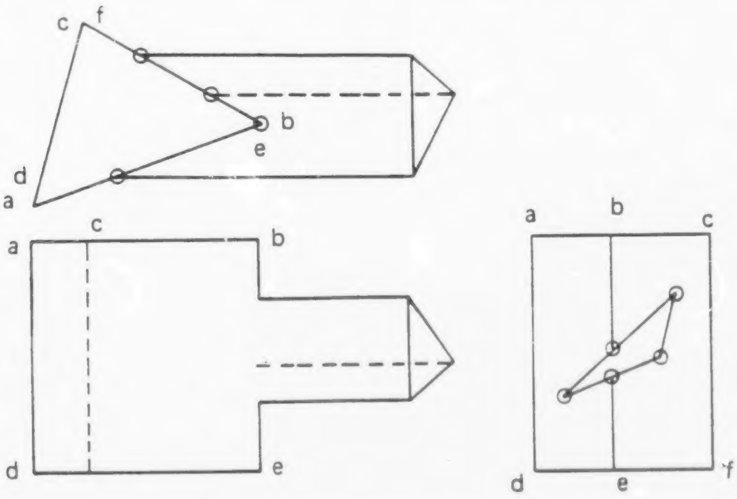
   NOTE: If edge views are not given, use auxiliary views to find them.



2. Observe edge views and circle points at the end of lines that intersect the edge views--these are called piercing points.

   a. Since all three piercing points are not on the same plane, line "be" should also be circled to make the line of intersection continuous.

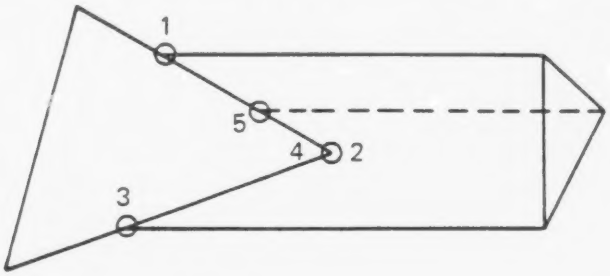
   b. Circle piercing points where "be" intersects the edges in the side view.



3. Follow the line of intersection between the two objects numbering them as you go.

   a. 1 and 2 are on the same top surface.

   NOTE: Point 5 is hidden and is on the bottom surface.



   b. Line 2-3 is on the top surface.

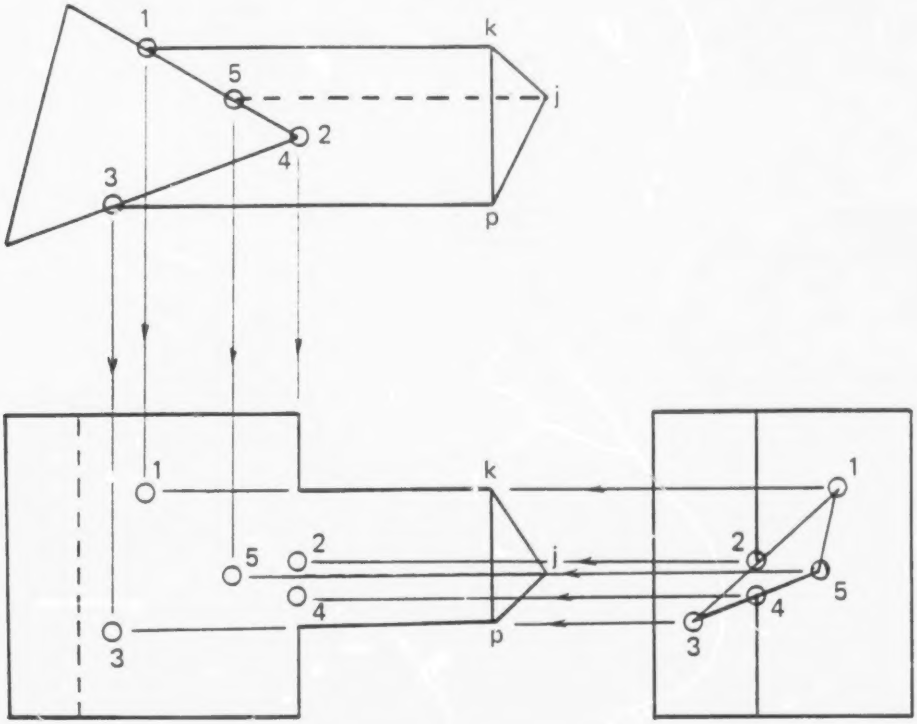
   c. Line 3-4 is on the bottom surface.

   d. Line 4-5 is on the bottom surface.

   e. Line 5-1 is on the bottom surface.

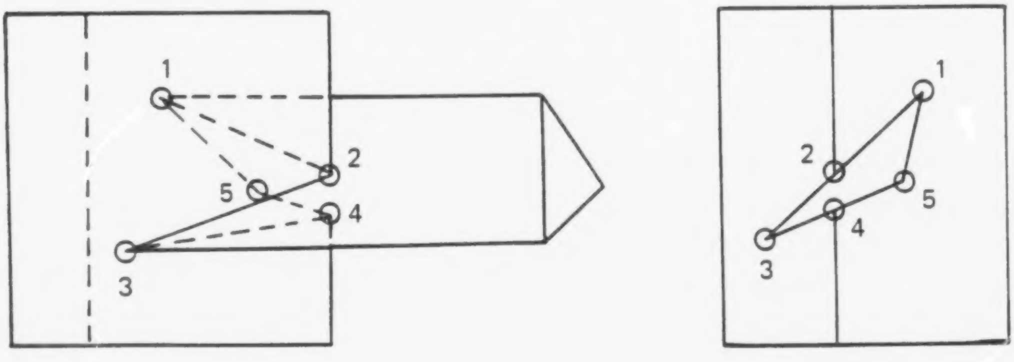
   f. The line of intersection is continuous ending with the same start point; your ability to visualize is very important in this process.

4. Project piercing points to front view intersecting corresponding lines; circle intersections.



NOTE: Points 2 and 4 must be projected from the side view. Another method for finding the piercing point of a line and a plane is the two-view method which will be covered in AS 3.3.

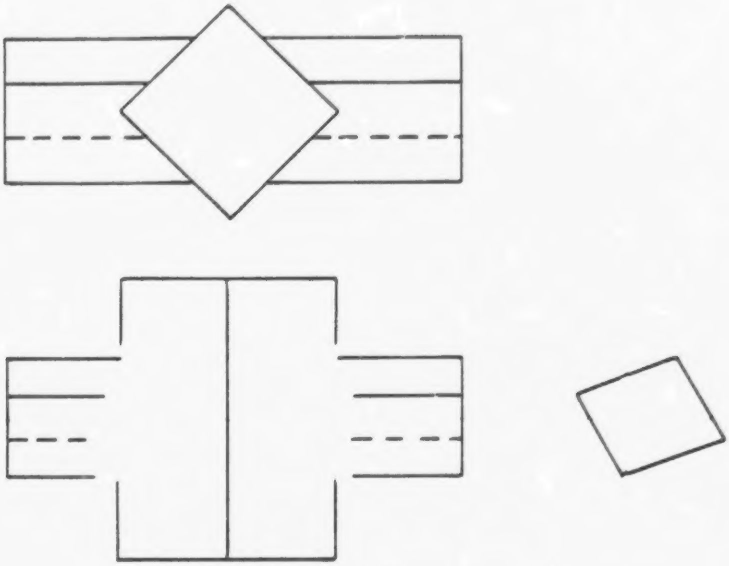
5. Connect piercing points to form line of intersection; use visualizing skills to determine visibility and if lines are near the observer or far from the observer.



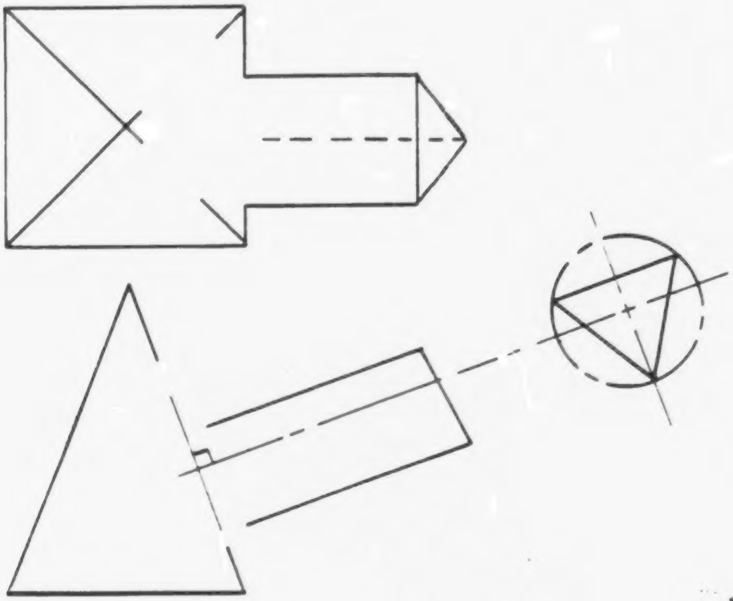
Problems:

Construct line of intersection between the parts shown. Circle piercing points and number line of intersection on all views.

A.

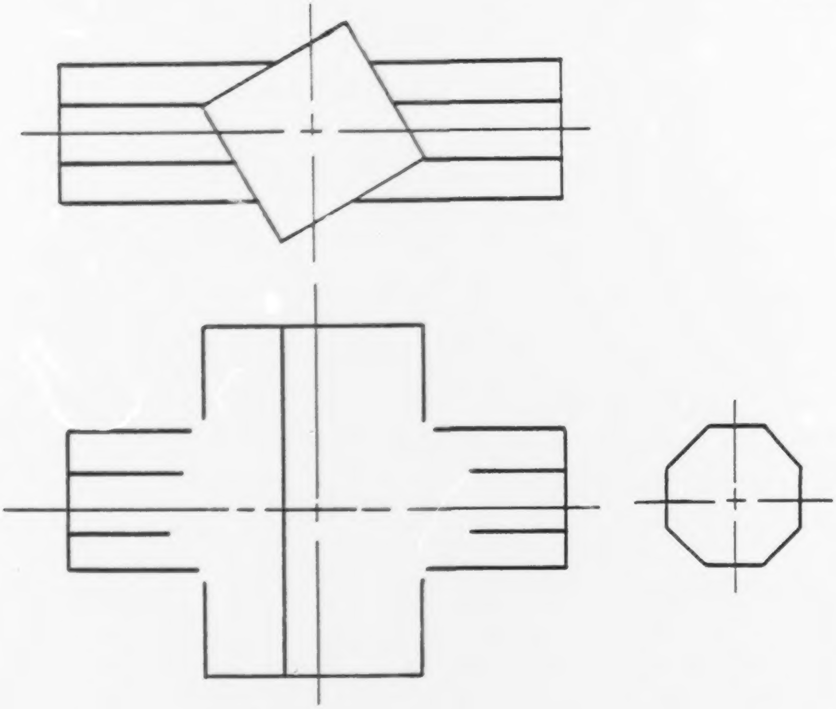


B.

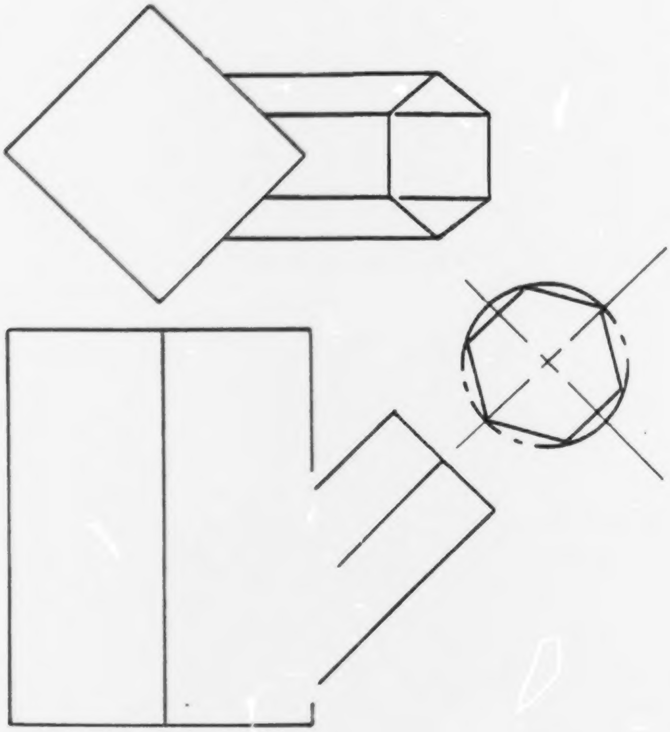


AS 3.2 continued

C.



D.

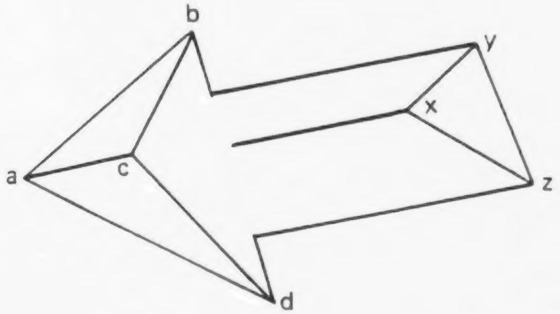


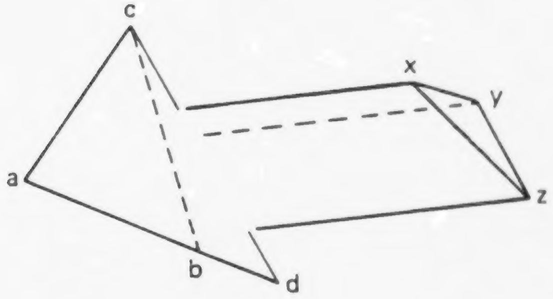
CONSTRUCT INTERSECTIONS OF SURFACES USING TWO-VIEW METHOD

Directions: Use the following example as a guideline for solving the problems of constructing intersections using the two-view method.

Example:

1. Identify and label all edge views if given and label all points.

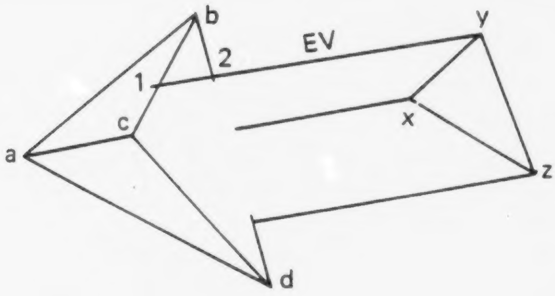




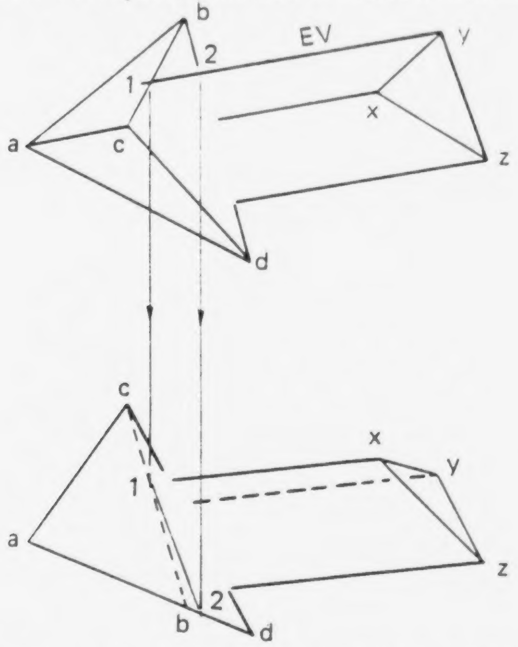
2. Take each line independently and locate its piercing point on the surface.

   a. Extend the line until it crosses two lines cb and bd on the plane you expect it to intersect; label intersections #1 and #2.

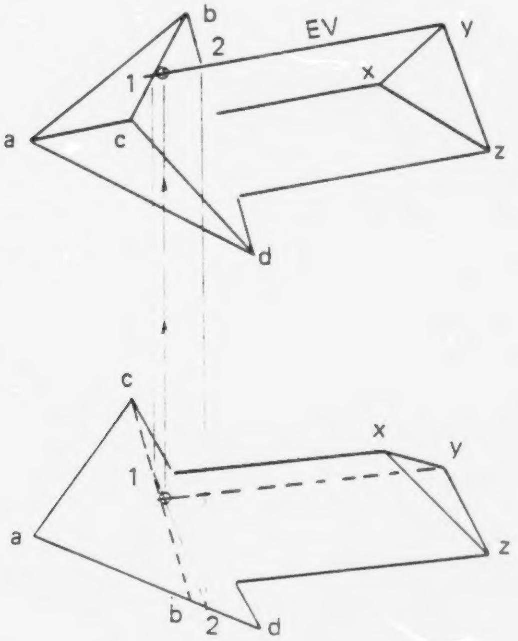
   NOTE: In this method, the line is marked EV to indicate the edge of an imaginary cutting plane.



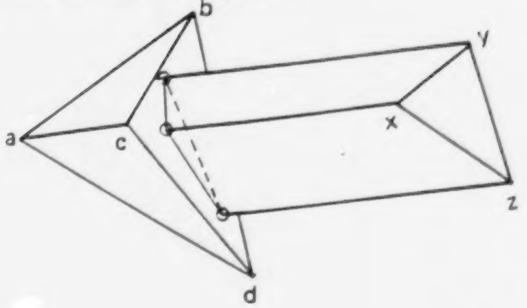
b. Project points 1 and 2 to adjacent front view to intersect lines cb and bd.

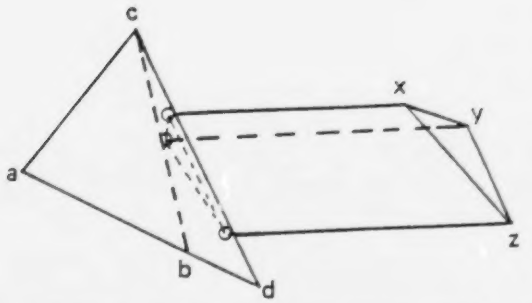


c. Draw a line between 1 and 2 where it intersects the line Y--that is a piercing point; mark piercing point, and project back to the one that we marked EV.



d. Use the same process to locate all piercing points.

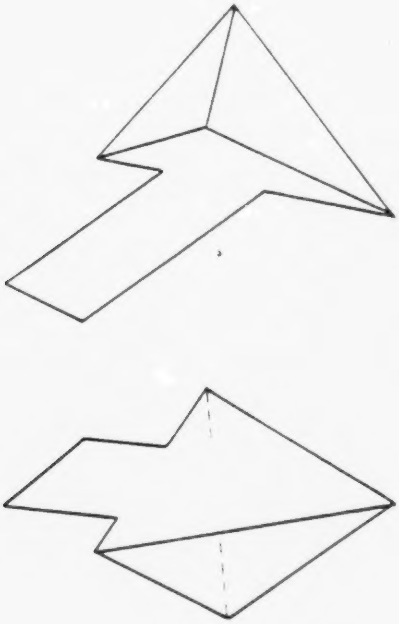




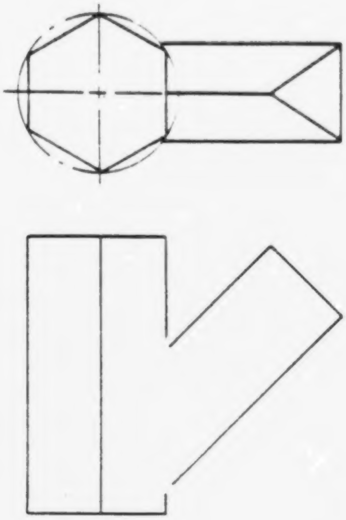
e. Connect piercing points to form line of intersection; use visualizing skills to determine visibility and if lines are near the observer or far from the observer.

Problems: Construct line of intersection between the parts shown. Use two-view method where appropriate. Circle piercing points and number line of intersection on all views.

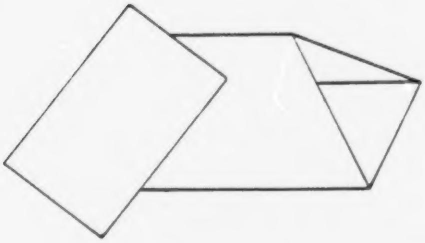
A.

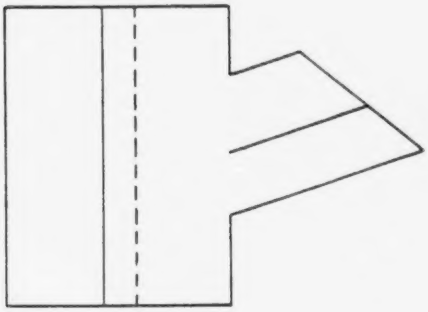


B.

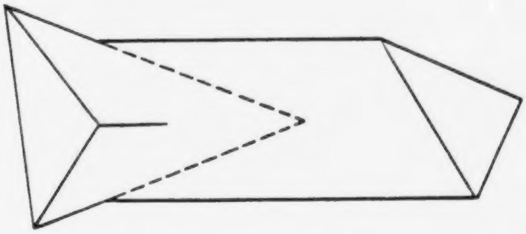


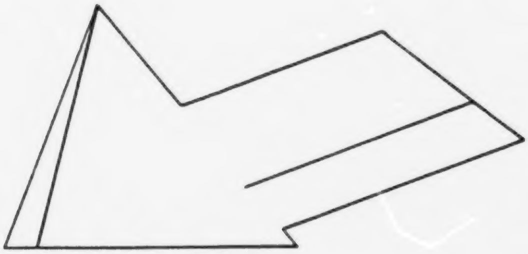
C.





D.





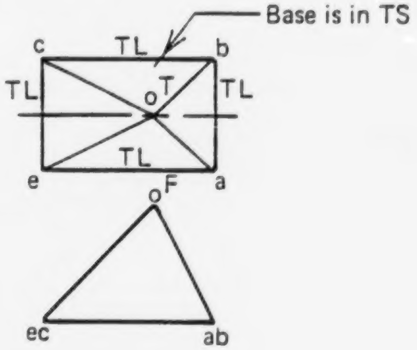
CONSTRUCT RADIAL LINE DEVELOPMENTS

Introduction: The objective of constructing sheet metal developments is to draw a true size flat pattern of the surface to be folded to the desired form. Edges are joined by seams, rivets, welding, soldering, and other means. Edge lengths should be kept to a minimum for economy and ease of handling. (Transparencies 3.8 and 3.9)

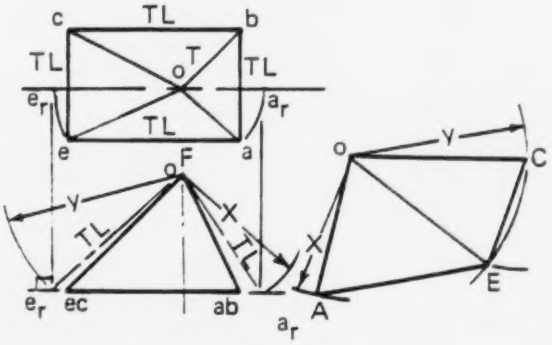
Directions: Construct radial line developments of pyramids, truncated pyramids, right circular cones, and oblique cones. An example is included for each of these.

Example A: Pyramids

1. Label all points, true length lines, and true size surfaces.



2. Find the true lengths of each inclined or oblique line by rotation using the vertex as the axis.

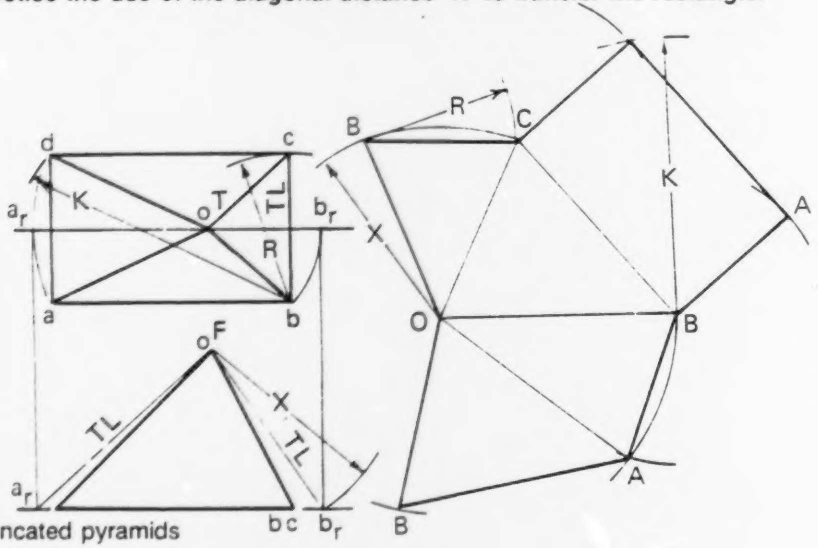


3. Decide where the seams will be located.

4. Lay out the surfaces in true size inside out.

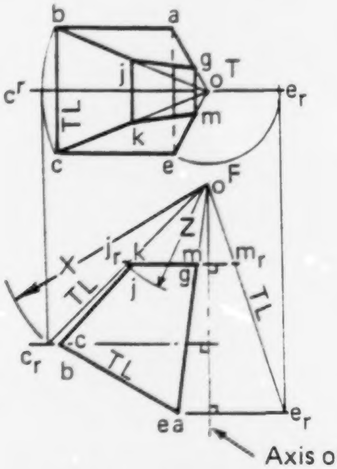
5. Complete the development making bend lines thin lines.

NOTE: Notice the use of the diagonal distance "K" to transfer the rectangle.



Example B: Truncated pyramids

1. Label all points, true length lines, and true size surfaces.

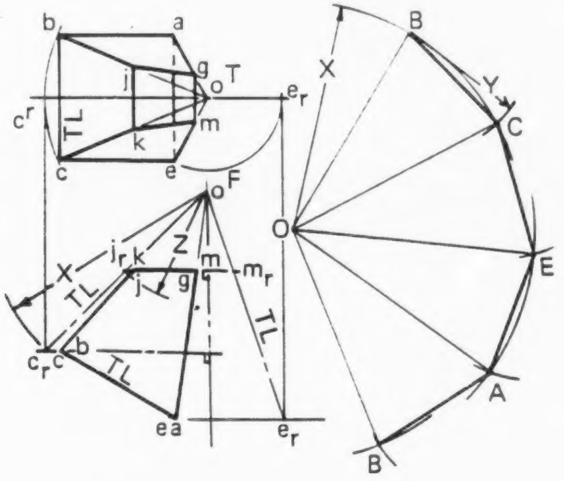


Axis of rotation

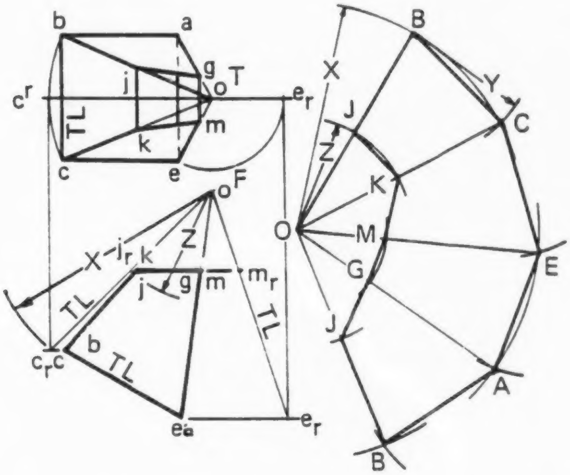
2. Find the true lengths of each inclined or oblique line by rotation using the vertex as center.

3. Since the object does not go to the vertex, project the intermediate distances perpendicular to the axis of rotation to obtain correct true lengths.

4. In more complicated drawings, a true length diagram is used to keep the drawing from becoming confusing.



5. Lay out the largest surfaces in true size inside up.



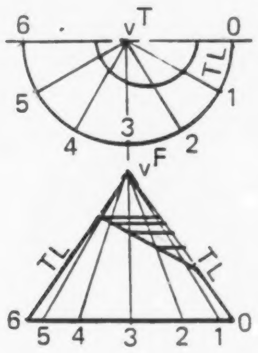
6. Lay out the smaller true lengths on the true length lines on the development.

7. Complete the development making bend lines thin lines.

Example C: Right circular cones

1. Label all points, true length lines, and true size surfaces.

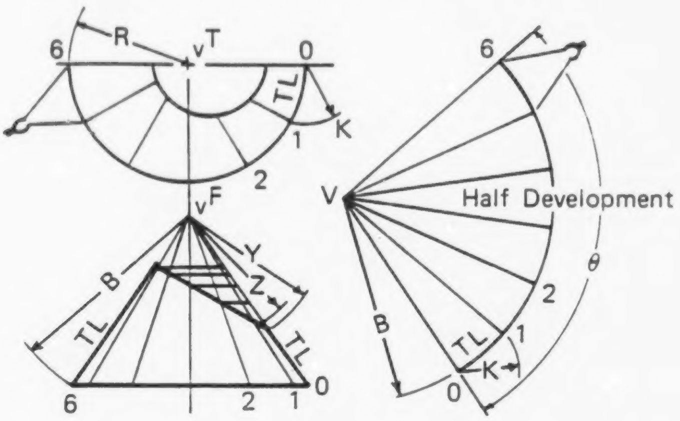
   NOTE: This example does not have any true size surfaces.



NOTE: By observation, the base of the cylinder is in true size in the top view.

2. Divide circular base into equal parts (normally every 15° or 30°) and draw the cone elements to the vertex; number each point.

3. Project elements to the front view and draw to the vertex.



4. Using the true length of the side of the cone as the radius, construct a semi-circle.

5. Use the following formula to compute the number of degrees of the semi-circle for a half development.

NOTE: In this example, R = 10; B = 20.

$$\theta = 1/2 \quad \left(\frac{R}{B} 360^\circ\right)$$

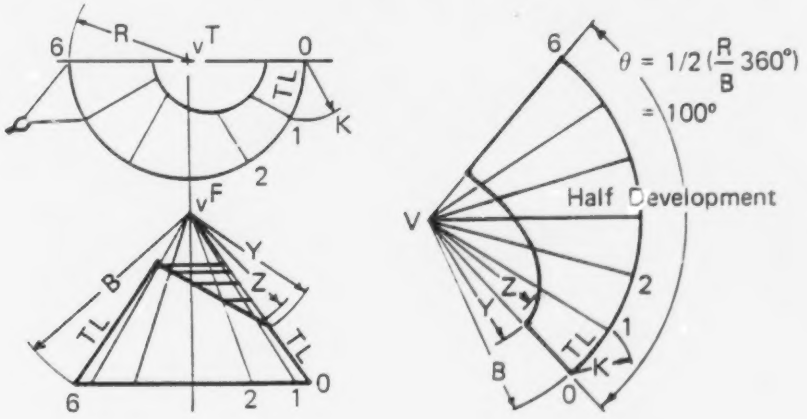
$$\theta = 1/2 \quad \left(\frac{10}{20} 360^\circ\right)$$

$$\theta = 90^\circ$$

NOTE: When the formula is used, the elements must be stepped off with dividers to divide the arc equally.

6. An alternate method, not as accurate, can be used.

   a. Step the chord distance from 0 to 1, etc. around the semi-circle.



   b. Construct the larger circle with a bow compass.

   c. Lay out the smaller true lengths on the developed true length lines.

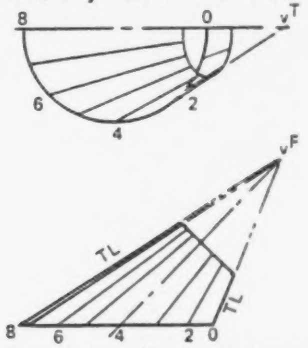
   d. Connect all points with an irregular curve.

   e. Complete the development by darkening all lines.

Example D: Oblique cones

1. Label all points, true length lines, and true sizes surfaces.

   NOTE: This example does not have any true size surfaces.

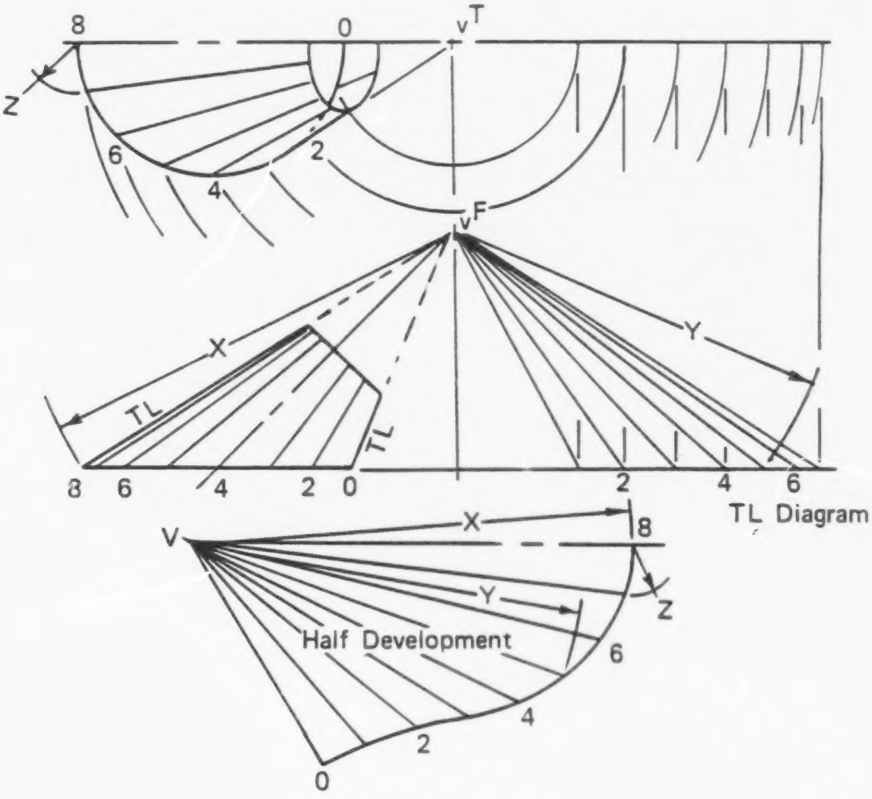


2. Divide circular base into equal parts and draw the cone elements to the vertex; number each point.

3. Construct a true length diagram by rotating points on the right side of the drawing.

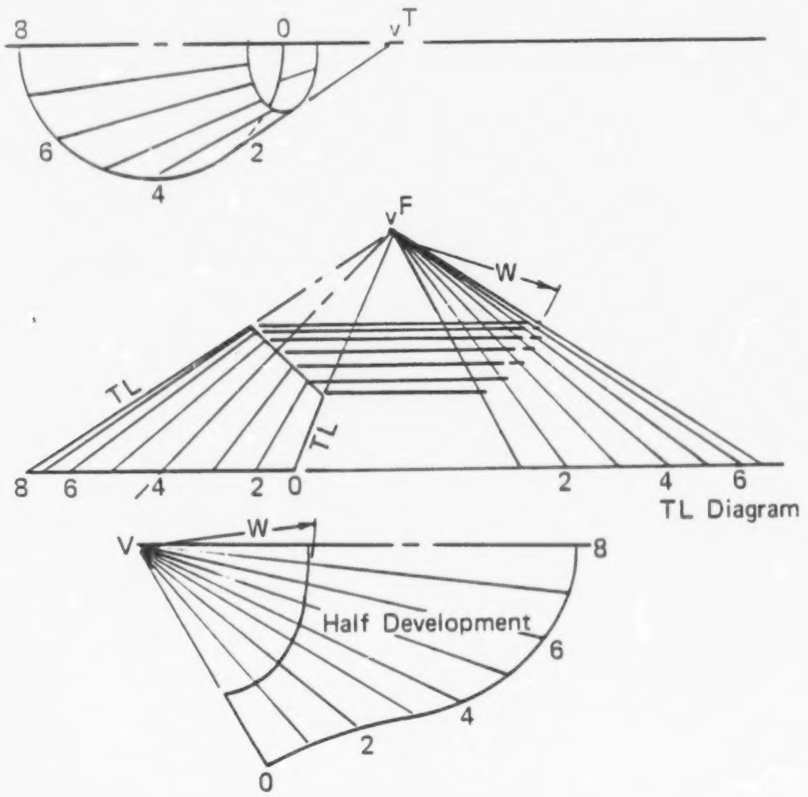
   NOTE: This helps to prevent confusion.

4. Project all elements intersection of the inclined surface to the TL diagram; this will give the correct length for the cut.



5. Layout one true length element at a time and one circular radius between elements at a time.

6. Connect all points using an irregular curve.



7. Layout the smaller true lengths on the developed true length lines.

8. Connect all points with an irregular curve.

9. Complete the development by darkening all lines.

Problems:

1. Construct each problem on a "B" size sheet of vellum or other media selected by instructor. Draw both the two-view drawing and the development. Add dimensions as instructed.

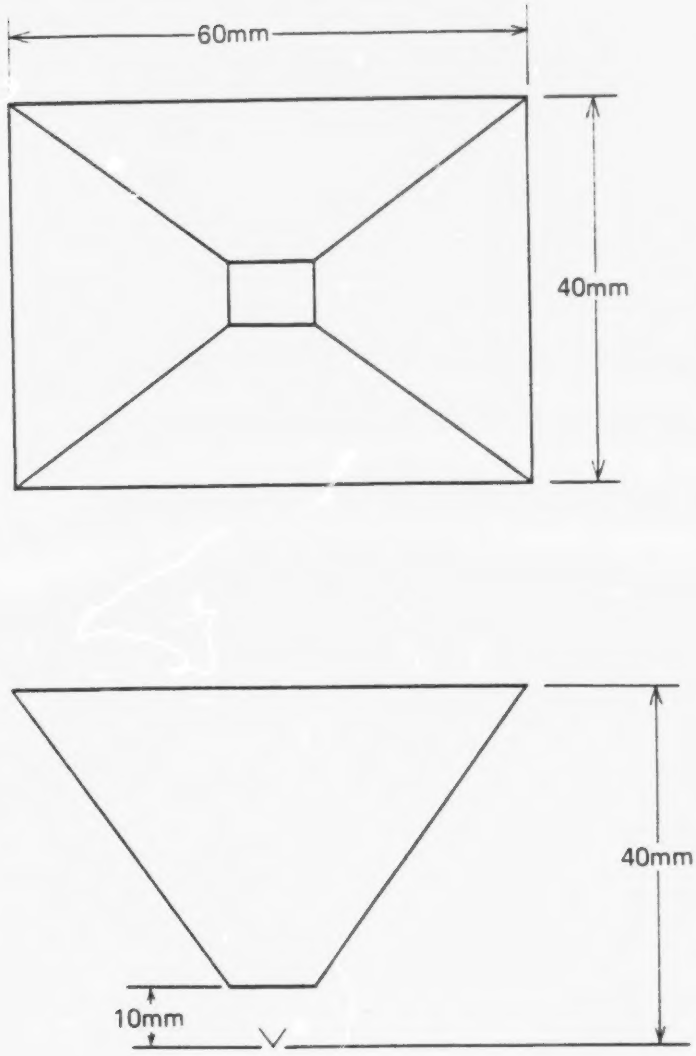
2. Make a blueline print of the drawing and cut the pattern out with scissors.

3. Tape or glue development together to form three dimensional part.

   NOTE: This is a good time to check your work.

4. Hand in both the original and the object to your instructor.

A.



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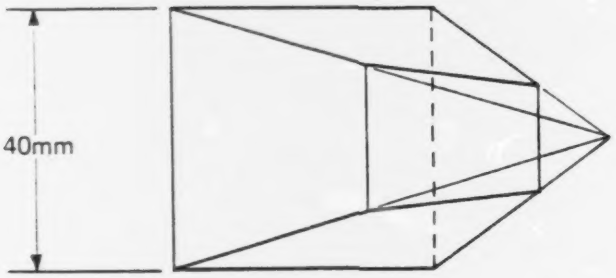

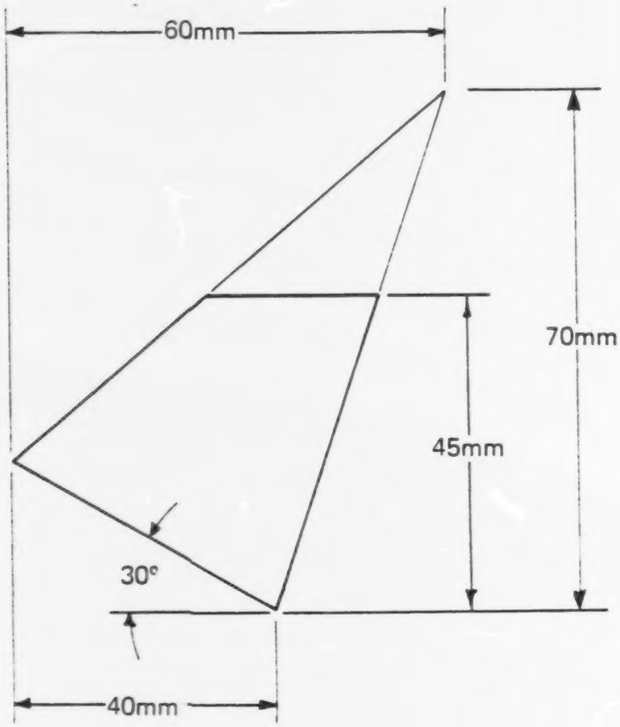

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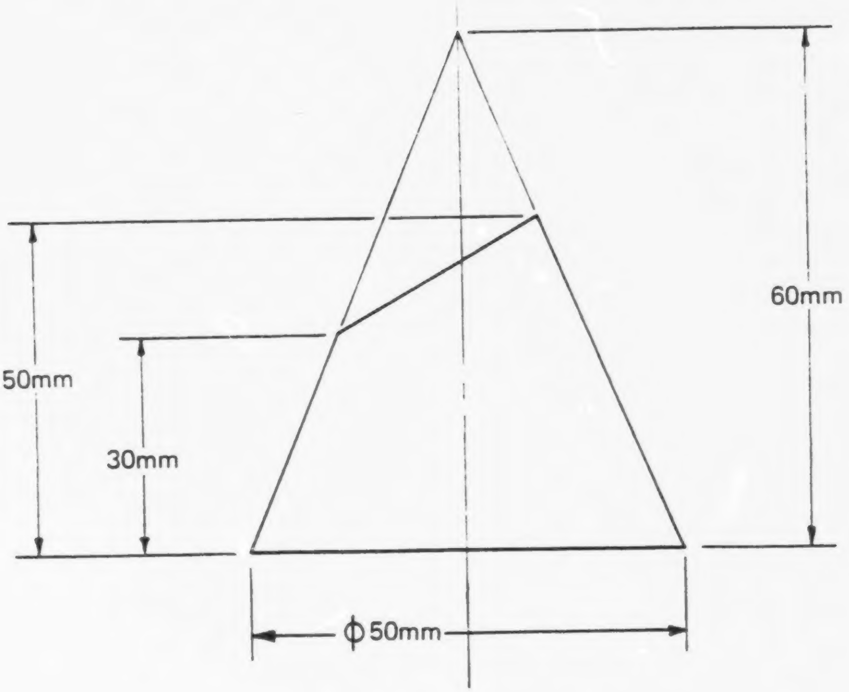

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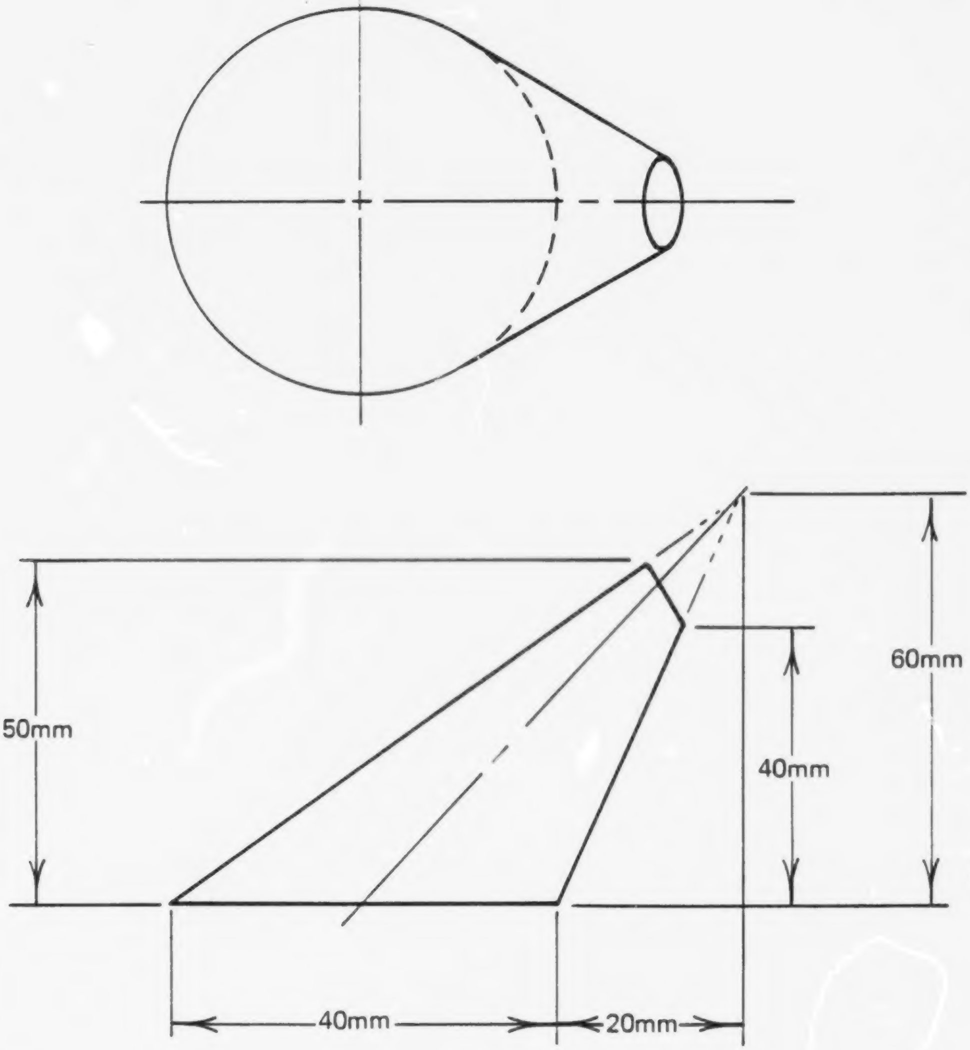
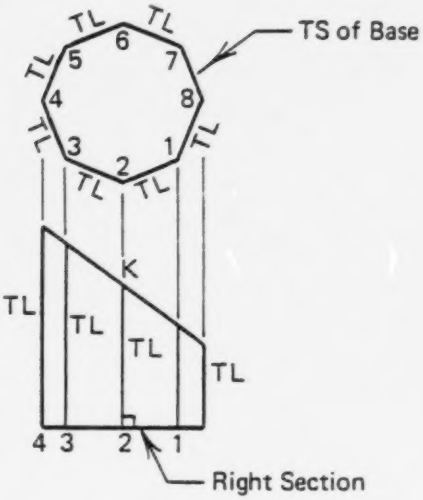


CONSTRUCT PARALLEL LINE DEVELOPMENTS

Directions: Construct parallel line developments of right prisms, oblique prisms, right circular cylinders, and oblique cylinders on "B" size media. Examples for each of these are included to be used as guidelines for solving the problems.

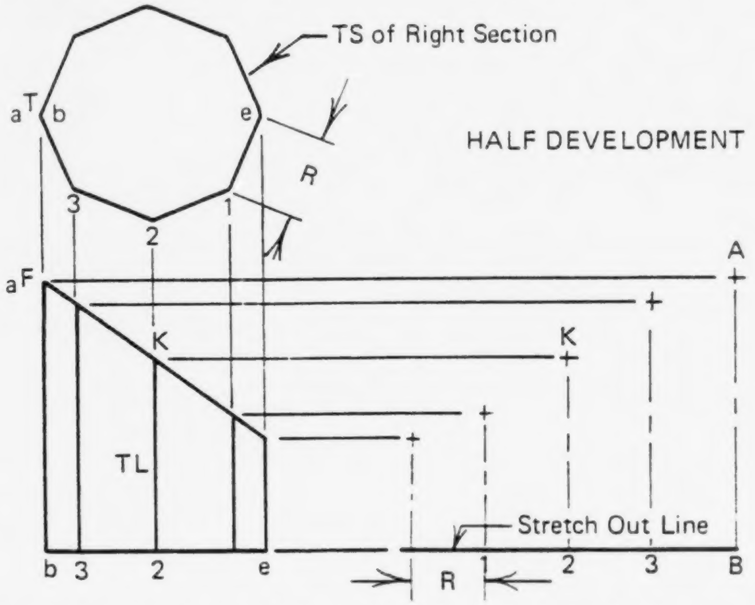
Example A: Right prisms

1. Label all points, true length lines, and true size surfaces.



NOTE: All lines are in true length except the inclined lines. Since the base is perpendicular to the octagon shaft, the corners formed on the planes are 90°. The top view is a right section of the base. When you have a right section, the solution to the problem is to transfer distances from the right section on a stretch out line.

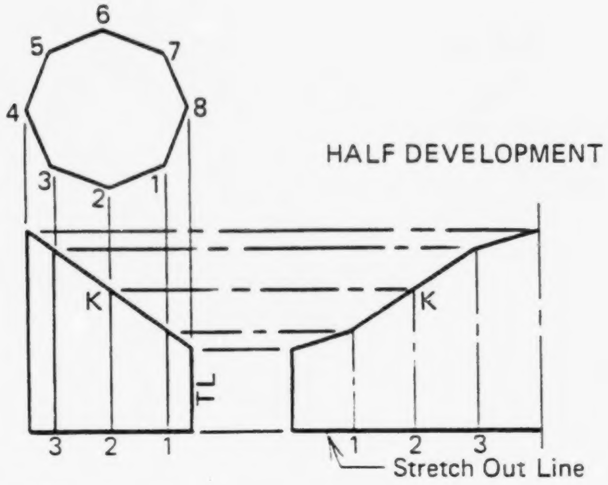
2. Project from the right section to the right hand area all true length vertical lines.



3. On the EV of the right section, mark off the true lengths of the base; this line is called a stretch out line.

NOTE: If a right section is not given, construct a right section perpendicular to the true length lines.

4. Draw the lines from the points on the base until they connect to the common points such as 2 connects to K.

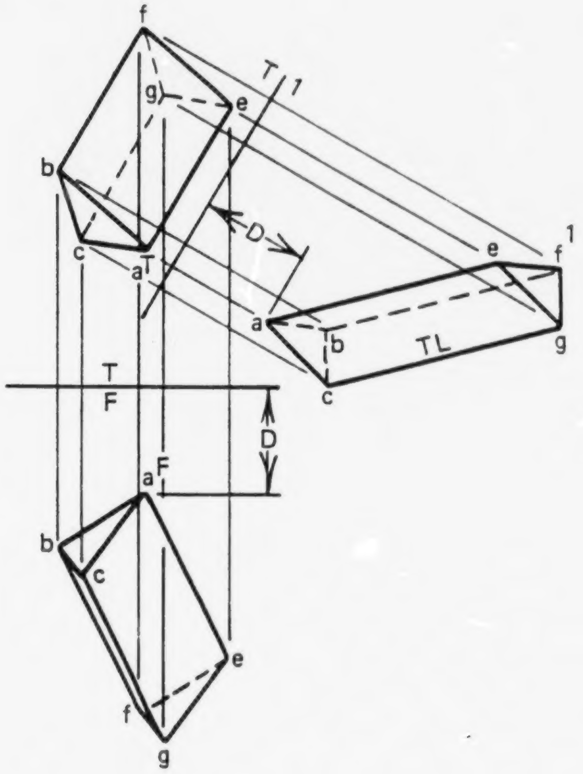


5. Complete the development making bend lines thin lines.

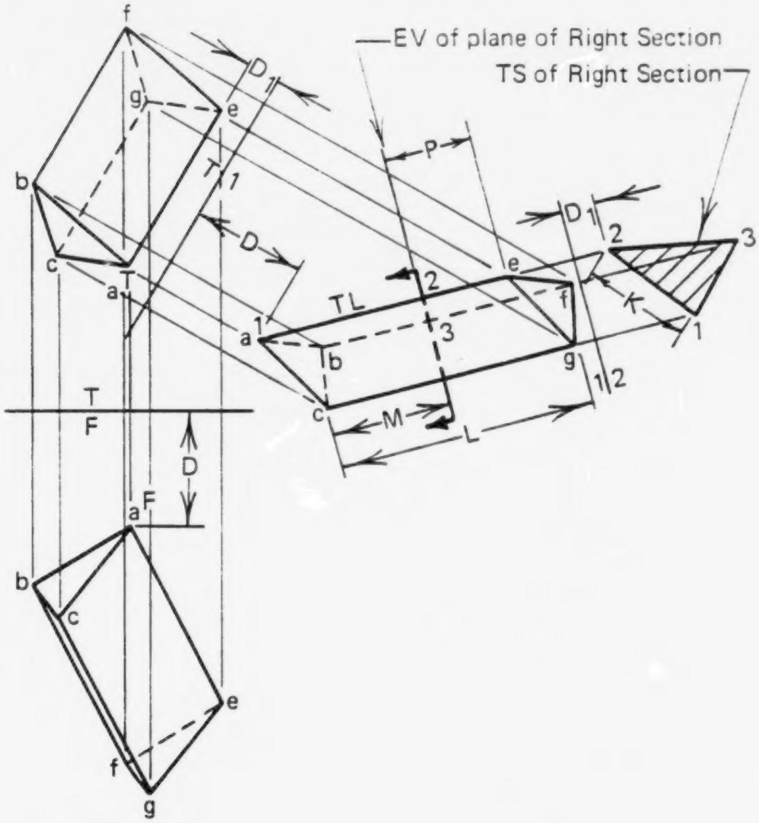
Example B: Oblique prisms

1. Label all points, true length lines, and true size surfaces.

NOTE: This example has no true length lines or true size surfaces.



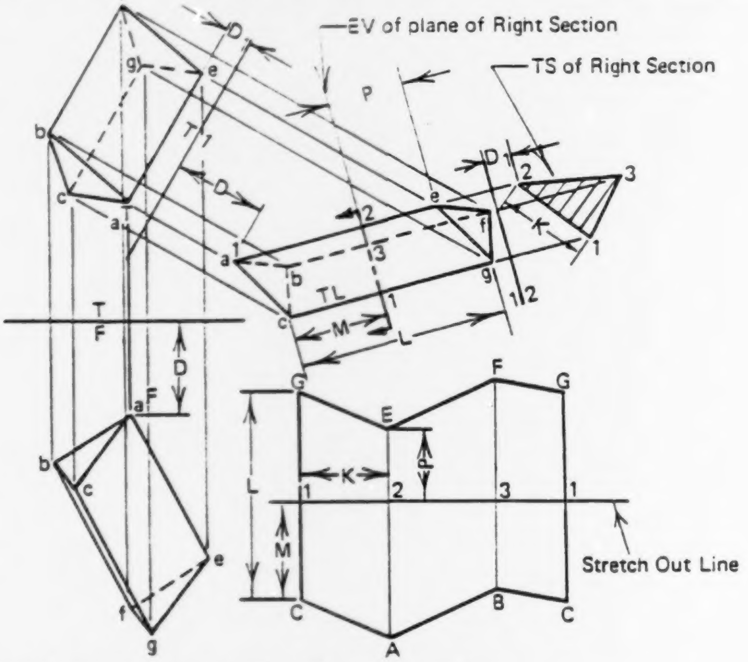
2. To develop an oblique prism that has no true length sides given, construct an auxiliary view to find the true lengths of the parallel sides.



3. Construct a true right section at a convenient location perpendicular to the TL of the parallel lines.

NOTE: This view is an edge view of the section.

4. Construct the true size of the right section by constructing the line of sight parallel to the true length lines.



5. In a convenient location, draw a horizontal stretch out line.

6. Transfer the true lengths of the sides from the TS right section view.

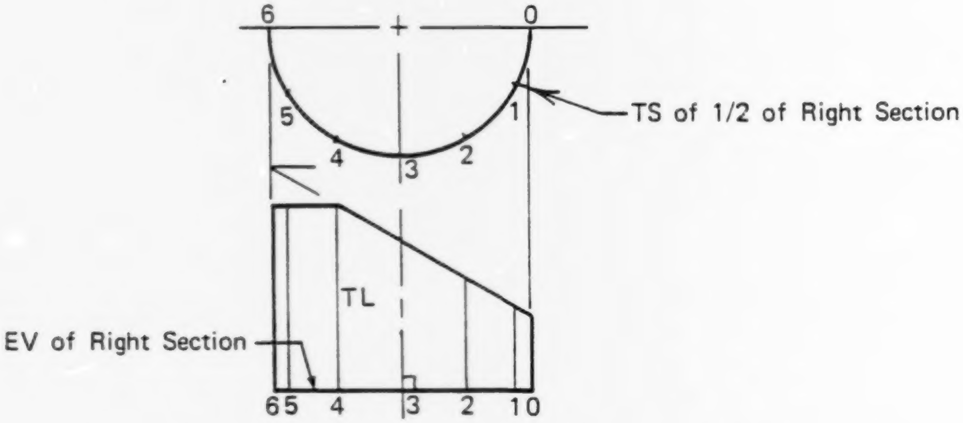
7. Construct vertical lines through the points.

8. Transfer true lengths of sides from the EV of the right section to the vertical lines.

9. Complete the developing making bend lines thin lines.

Example C: Right circular cylinders

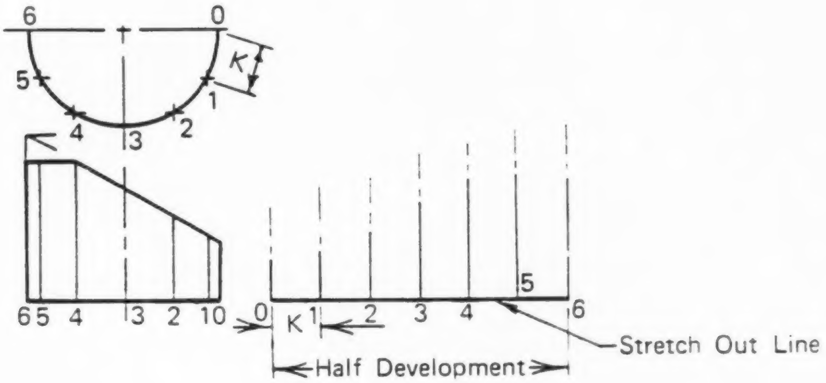
1. Label all points, true length lines, and true size surfaces.



2. By observation, the base of the cylinder is in true size in the top view.

3. Divide circular base into equal parts (normally ever 15° or 30°).

4. Project points (actual end view of elements) to front view and draw the elements parallel to the center line.

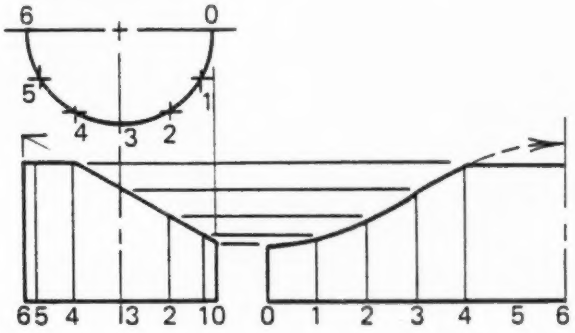


5. Project horizontal stretch out line from EV of right section.

6. Transfer distances from top view from point 0 - 1 to stretch out line.

NOTE: The distance laid out is 1/2 circumference.

7. Project vertical lines from each point on stretch out line.

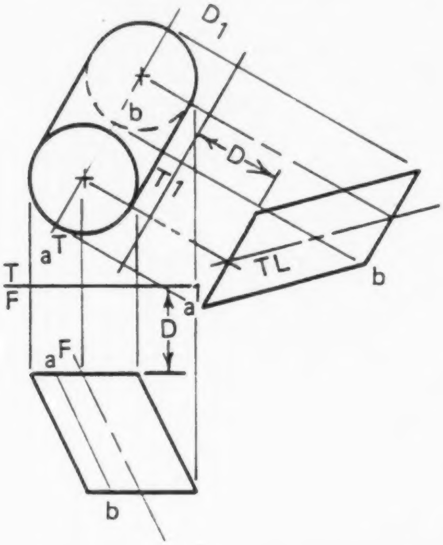


8. Project points from inclined top edge of elements in front view to corresponding elements in development area.

9. Complete the developments by connecting points with an irregular curve.

Example D: Oblique cylinders

1. Label all points, true length lines, and true size surfaces.

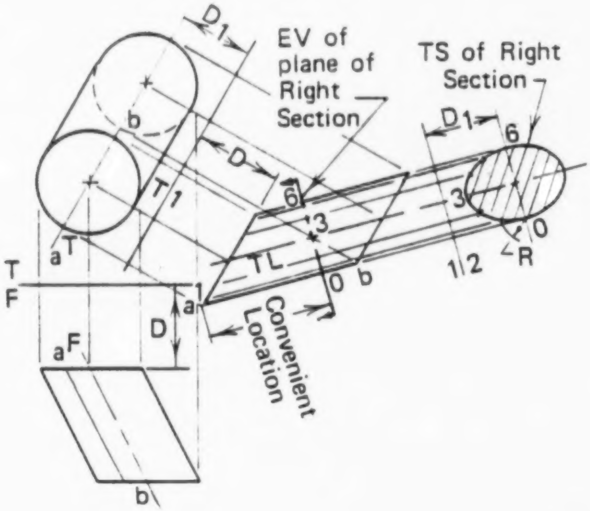


2. To develop an oblique prism that has no true length center line given, construct an auxiliary view to find the true length of the center line.

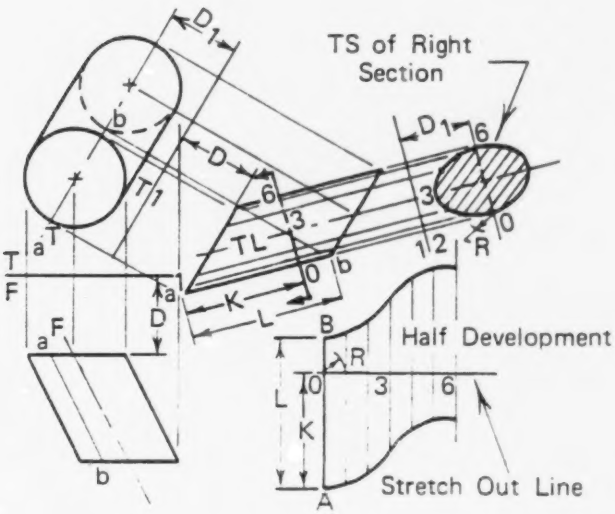
3. Construct a true right section at a convenient location perpendicular to the TL of the center line.

   NOTE: This view is an edge view of the section.

4. Construct the true size of the right section by constructing the line of the sight parallel to the TL of the center line.



5. Divide the ellipse right section into equal parts and project back to view with TL center line; these lines are elements of the cylinder and are in TL.



6. In a convenient location, draw a horizontal stretch out line.

7. Transfer the distances between the point view of the elements in the TS right section view to the stretch out line.

8. Project vertical lines from each point on the stretch out line.

9. Transfer TL of elements from the EV of the right section to the vertical lines.

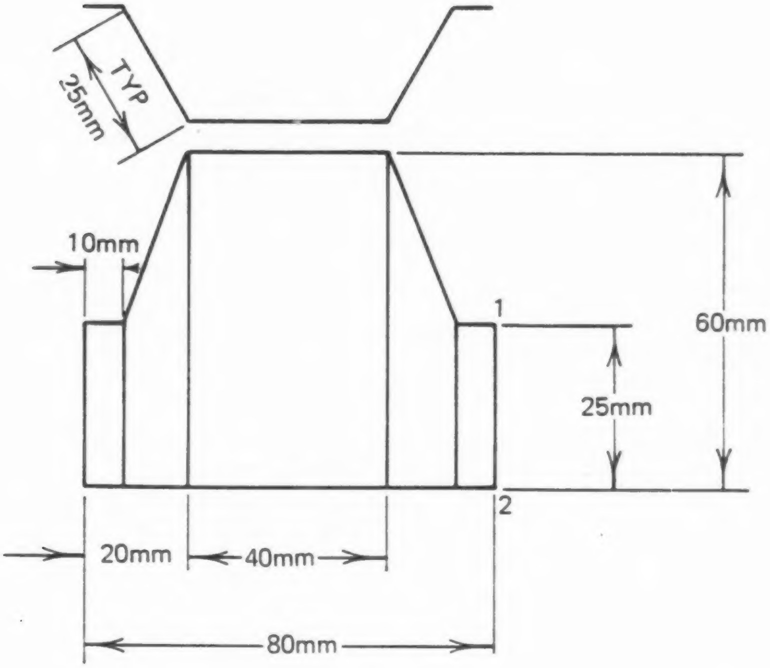
10. Complete the view using an irregular curve.

Problems:

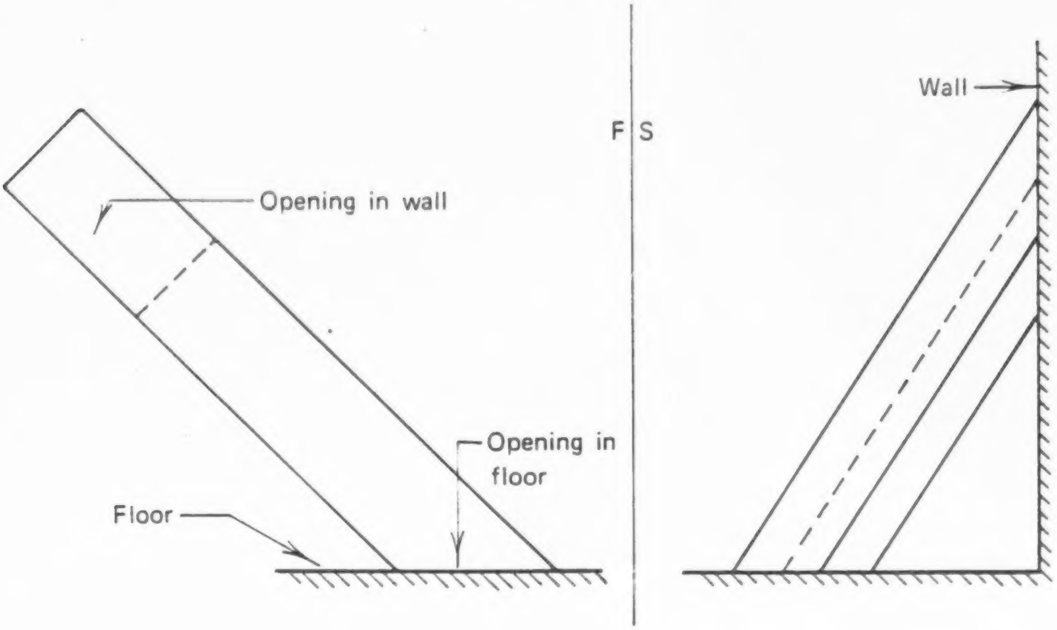
1. Construct a development for each problem on a "B" size sheet of vellum or other media selected by instructor. Draw both the two-view drawing with all construction lines and the development. Add dimensions as required by instructor.
2. Make a blueline print of the drawing and cut the pattern out with scissors.
3. Tape or glue development together to form three dimensional part.

   NOTE: This is a good time to check your work.
4. Hand in both the original and the object to your instructor.

A.



B. Transfer dimensions to "B" size media. Part is inclined at an angle of 25° to wall.



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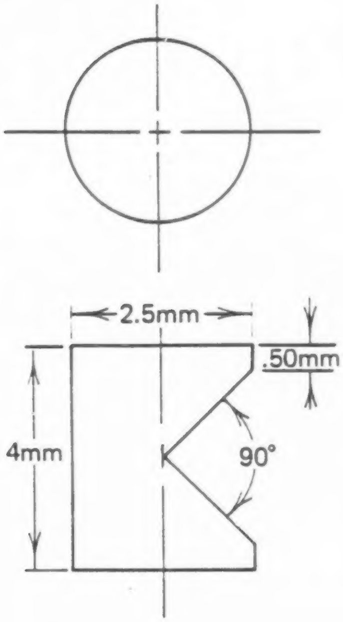


CONSTRUCT SPECIAL DEVELOPMENTS USING TRIANGULATION

Introduction: Many surfaces cannot be developed by the radial line or parallel line methods. Some of these other surfaces can be developed or approximately developed using triangulation. As the name triangulation implies, this method divides surfaces into triangles which can be easily constructed. (TM 3.12)

Example: Is this four-sided figure ABCD a flat plane? It looks to be, but when we examine the diagonal lines, we find they do not intersect!

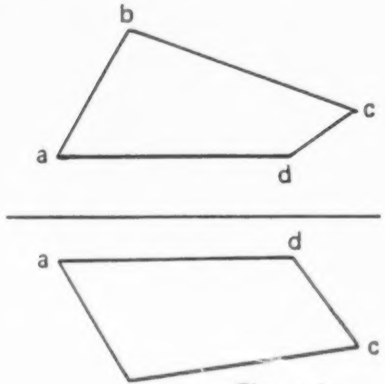


Figure 1

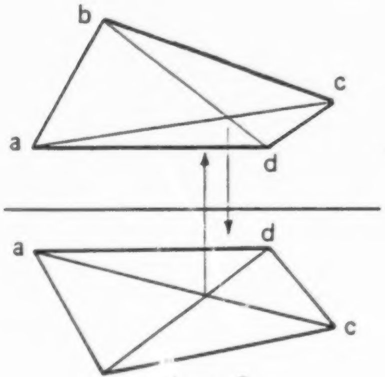
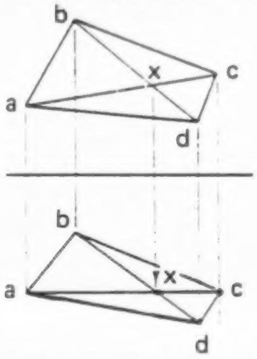


Figure 2

The plane constructed in Figure 1 is not a true flat plane but is, in fact, a warped plane.

To construct a four- or more sided plane, we must first divide the surface into triangles, then project the triangles to the adjacent view including the intersection of the diagonals. Line ax is extended to locate point C. The resulting four-sided figure is a flat plane.

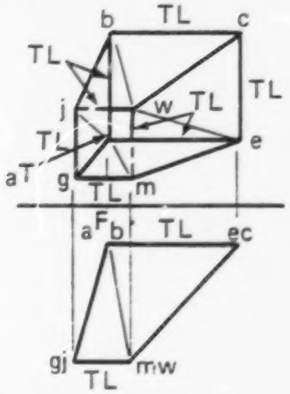


This concept is important when constructing drawings. The optical illusion of a flat plane with four or more sides is easy to draw. Always construct oblique planes with three or more sides using this triangulation method.

Directions: Construct plane surfaces and transition pieces using triangulation on "B" size media. Examples are included to be used as guidelines for solving the problems.

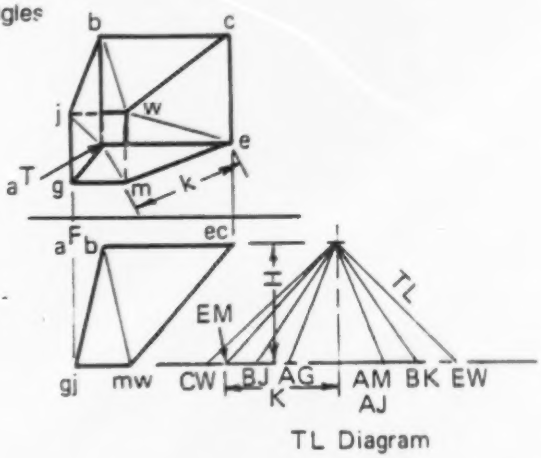
Example A: Plane surfaces by triangulation

1. Label all points, true length lines, and true size surfaces.



NOTE: This plane surface hopper is not part of a pyramid and cannot be developed using radial line or parallel line methods.

2. Divide each surface into triangles



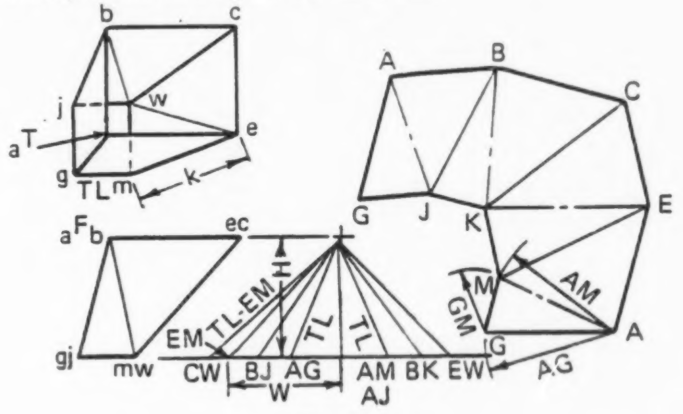
3. Set up a true length diagram next to the front view to prevent confusion in the front view.

4. Project the height (H) directly to the true length diagram; this is the same as saying, project the edge view of the path of rotation.

AS 3.6 continued.

5. Transfer directly to the true length diagram the distance (W) that is normally rotated until it is parallel to the folding line.

6. Label all lines correctly on the TL diagram for future use.



TL Diagram

7. Select an open area on the drawing to start the development; allow lots of space.

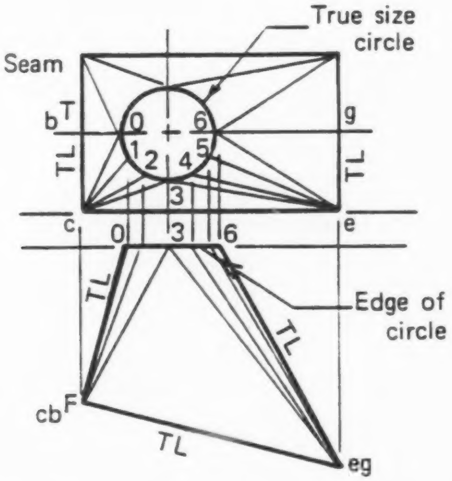
8. Take true length dimensions of each triangle from those given and those of the TL diagram.

9. Construct the triangles forming the sides of the surfaces; always start with the shortest side.

10. Complete the development by adding bend lines.

Example B: Transition piece by triangulation

1. Label all points, true length lines, and true sizes.

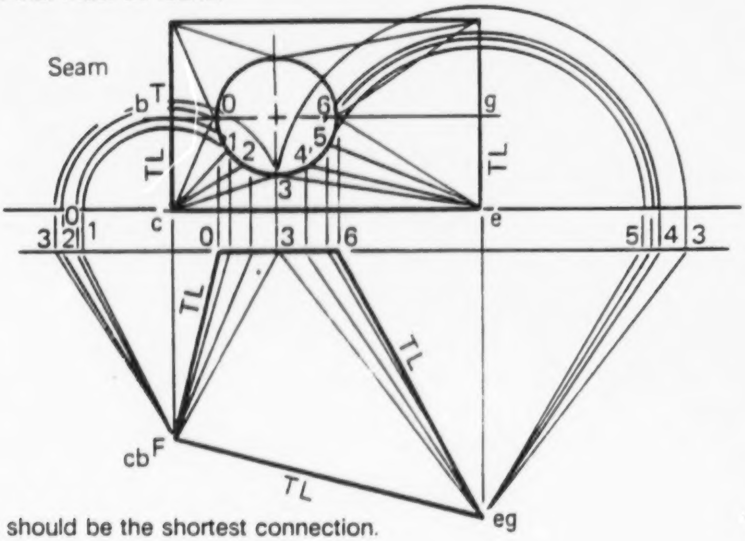


NOTE: This transition piece goes from a circular part to a rectangular part.

2. Divide the circle into equal parts (normally 15° to 30° increments).

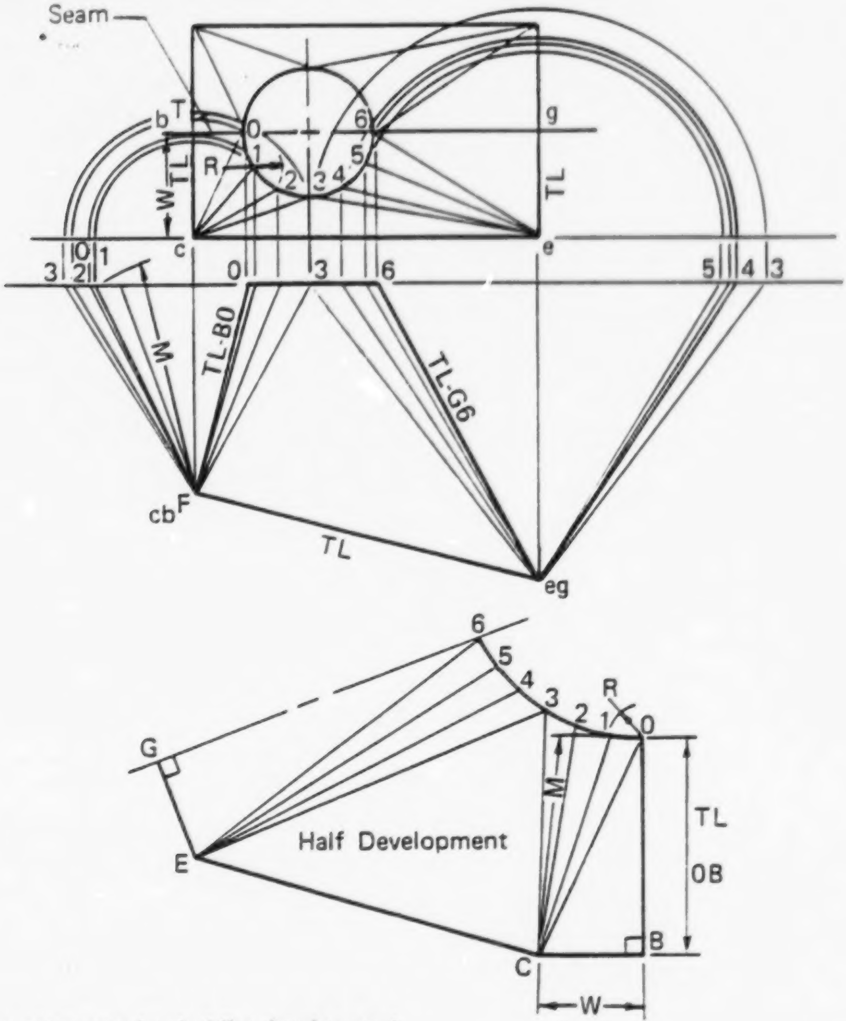
3. Draw common elements in both views forming triangle surfaces from the circle to the rectangle.

4. Observe the number of true lengths that must be found.



5. Determine where seam will be; this should be the shortest connection.

6. Construct TL of all elements by using a TL diagram or other means.



7. Select an open area to start the development.

8. Starting with the seam, develop inside out by constructing triangles of each surface.

9. Take true length dimensions of each triangle from the chord distance on the circle, those TL given, and those found on the TL diagram.

10. Complete the development by adding bend lines.

Problems:

1. Construct each problem on a "B" size sheet of vellum or other media selected by instructor. Draw both the two-view drawing and the development. Add dimensions as instructed.

2. Make a blueline print of the drawings and cut the pattern out with scissors.

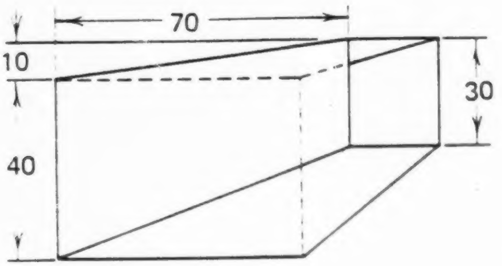
NOTE: Half patterns will need to be doubled.

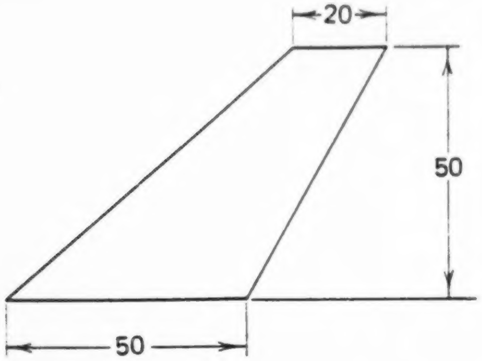
3. Tape or glue development together to form three dimensional part.

NOTE: This is a good time to check your work.

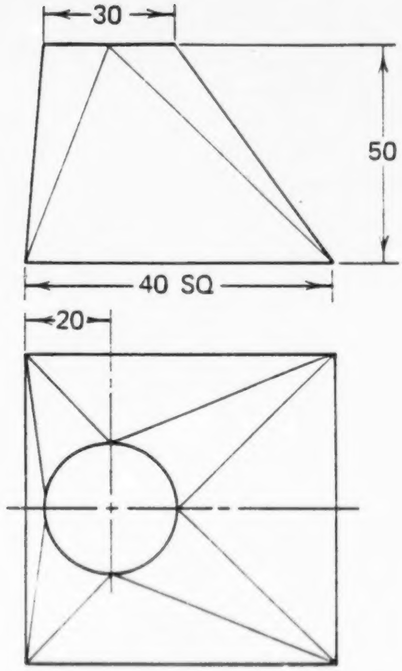
4. Hand in both the original and the object to your instructor.

A.

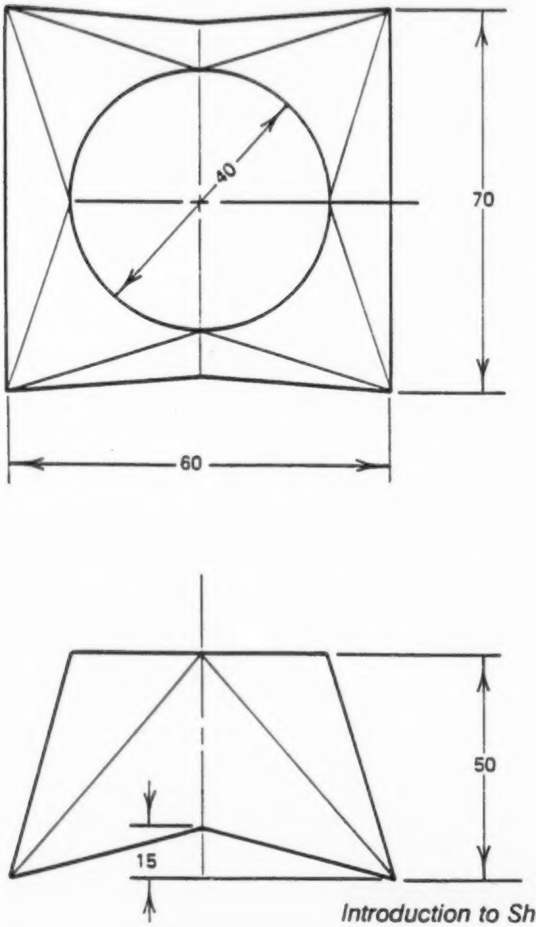




B.



C.



MODULE: INTRODUCTION TO PRODUCTION/MANUFACTURING DRAFTING

UNIT III: INTRODUCTION TO SHEET METAL DRAWINGS

ANSWERS TO ASSIGNMENT SHEETS

All assignment sheets are to be evaluated to the satisfaction of the instructor.

MODULE: INTRODUCTION TO PRODUCTION/MANUFACTURING DRAFTING

UNIT III: INTRODUCTION TO SHEET METAL DRAWINGS

UNIT TEST

Match the terms on the right with the correct definitions.

____ 1. The exact measurable view of the exact length of a line found by observation, projection, or calculation

____ 2. The exact measurable view of the exact size of a surface found by observation, projection, or calculation

____ 3. A pattern of the true sizes of unfolded or unrolled surfaces arranged to be folded to the desired shape

____ 4. An additional amount of material necessary when making a bend

____ 5. The development of objects that can be developed due to elements radiating from a single point or vertex

____ 6. The development of objects that can be developed due to parallel elements on these surfaces

____ 7. A method of developing surfaces not possible by the parallel line or radial line methods

____ 8. A diagram of the true lengths projected from the normal views

____ 9. Ruled lines on the surface of geometric shapes

____ 10. A surface which has no straight line elements and cannot be developed

____ 11. Any surface generated by a straight line

____ 12. A ruled surface generated by a straight line that can be developed

____ 13. A piece that connects two differently shaped conductors

____ 14. A reference line normally between two views representing the edge of a plane of projection

____ 15. A line that is perpendicular to each element on which a parallel line development is unrolled or unfolded

a. Radial line development

b. Double curved surface

c. Transition piece

d. Folding line

e. True length diagram

ab. True size of a surface

ac. Single curved surface

ad. Development

ae. Triangulation

bc. Stretch out line

bd. Bend allowance

be. True length of a line

cd. Elements of a surface

ce. Ruled surface

de. Parallel line development

Select true statements concerning important characteristics of rotation by placing an "a" in the appropriate blanks. Place a "b" in the blanks of false statements.

NOTE: All parts of a statement must be true before you place an "a" by that statement. If one part is false, the whole statement is considered false.

16. ____ The path of rotation of any point not on the axis appears as a rectangle in a view showing the axis of rotation as a point.

17. ____ The plane of the path of rotation of any point appears in edge view (EV) and perpendicular to the axis in a view showing the axis of rotation in true length.

18. ____ A line may be rotated until it is parallel to a principal plane.

19. ____ The line is projected onto the adjacent plane.

20. ____ Since it is parallel to the folding line, it is not in true length in the adjacent plane.

21. List two methods for finding intersections of surfaces.

    a. ______________________________

    b. ______________________________

22. Name the three general groups of developments.

    a. ______________________________

    b. ______________________________

    c. ______________________________

MODULE: INTRODUCTION TO PRODUCTION/MANUFACTURING DRAFTING

UNIT III: INTRODUCTION TO SHEET METAL DRAWINGS

ANSWERS TO UNIT TEST (Q 2 and 3)

1. be
2. ab
3. ad
4. bd
5. a
6. de
7. ae
8. e
9. cd
10. b
11. ce
12. ac
13. c
14. d
15. bc
16. b
17. a
18. a
19. a
20. b

21. Any two of the following:
    a. Edge view given
    b. Auxiliary view method
    c. Cylinders intersecting
    d. Approximate intersections

22. a. Radial line
    b. Parallel line
    c. Triangulation